THE

POPULAR SCIENCE MONTHLY.

SEPTEMBER, 1886.

EX-PRESIDENT PORTER ON EVOLUTION.*

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THE great intellectual issue of the present day, however some may try to disguise it, is that between dogma on the one hand and the free spirit of scientific inquiry on the other. In using the word dogma, we have no wish to employ the argument *ad invidiam*—to take advantage, that is to say, of the popular prejudice no doubt attaching to recognized *dogmatism*. No, we frankly confess at the outset that a man may argue for dogma without betraying any dogmatic spirit; and that there would therefore be no fairness in embracing dogma and dogmatism in a common condemnation. None the less do we maintain that dogma is opposed to the free scientific spirit; and that the world is now being summoned to decide which of the two it will take for its guide. A definition of dogma, as we understand it, is therefore in order. By dogma we mean a traditional opinion held and defended on account of its assumed practical value, rather than on account of its truth—an opinion that is felt to require defending; that, like our "infant industries," needs protection; and round which its supporters rally accordingly. When great and special efforts are being made to place and keep a certain opinion on its legs, so to speak, be sure that it is a dogma that is concerned, and not any product of the free intellectual activity of mankind.

The last writer of eminence who has "come up to the help of the Lord against the mighty," or, in other words, to the help of orthodoxy against evolution, is Dr. Noah Porter, ex-President of Yale. Dr. Porter is a man who has lived for many years in an atmosphere of philosophical discussion, as well as of high literary cultivation; and

* Evolution. A Lecture read before the Nineteenth Century Club, May 25, 1886. By Noah Porter, D. D., LL. D., ex-President of Yale College. Herbert L. Bridgman, 55 Park Place, New York. 1886. Pp. 33.

we could perhaps scarcely name an American whom the common voice would pronounce better fitted to grapple with every phase of the doctrine of evolution in a logical and scholarly manner. We must confess, however, to a certain amount of disappointment with both the matter and the manner of the learned ex-president's "Lecture on Evolution," delivered before the Nineteenth Century Club, on the 25th of May last, and now reprinted for general circulation in pamphlet form. Our objections to the *matter* will appear as we proceed: our objection to the *manner* is that the learned ex-president has really not been so careful as he should have been—as one would suppose he would, almost by instinct, be—to clothe his thoughts in correct literary, or, let us say at once, grammatical form. One does not like to discuss questions of grammar in connection with a discussion of evolution; but, really, there is ground for complaint when a writer of the high competence of Dr. Porter embarrasses and irritates the reader of his lecture by simple inattention to the rules of composition.

The reader is not left long in doubt as to Dr. Porter's point of view. He says, in effect, at the outset, that the question of evolution might be left for scientists and philosophers to settle between them were it not for the fact that, as frequently presented, it involves consequences to Christian theism and natural ethics: this fact renders the intervention of the theologian necessary. Here we see the issue plainly formulated between dogma on the one hand and the free conclusions of the human intellect on the other. The theologian must intervene—why? What does he know of the matter in hand that "scientists and philosophers" may not equally know? Why should the interests of truth be dearer to him than to them? It will scarcely be pretended that the special knowledge of doctrinal systems in their succession and relation, or of the textual criticism of the Scriptures, which a professed theological student might be supposed to possess, would be of any great service in a discussion of the Darwinian theory or of the larger aspects of biological evolution. Yet, unless the theologian intervenes by virtue either of such special knowledge or of some special authority of a sacerdotal kind with which he claims to be invested, we fail to see how he can be said to intervene *as a theologian* at all. If he simply joins in the discussion on general grounds, contributing his quota of information or of logical discrimination, as any one else might do, why, then, he merely sits down with the "scientists and philosophers"; and happy is he if he can hold his own in such good company. Now, the truth is, that the learned doctor's intervention has been precisely of this kind. We fail to discover that he has uttered a single word in his character as a theologian, or done the least thing to show that evolution can not be safely and thoroughly discussed on grounds of science and philosophy. The only significant thing about his intervention is the *animus*. He thought he could deal with the matter as a theologian and he wished to do so. His

feeling at the outset doubtless was, and perhaps still is, that science and philosophy *ought* to be amenable to some higher control; but he has totally failed to show that such is the case. He finds that only by talking the language of science can he come into contact with science; and so with philosophy; and that there is no higher bar than their own before which these can be summoned. The result is instructive for all who lean to the opinion that Theology is still queen of the sciences, and that her writ runs through the whole domain of human knowledge. The return made to that writ in the most flourishing portions of the intellectual world to-day is: "No jurisdiction! Come down to facts!"

The ex-President of Yale is not opposed, he tells us, to evolution in every aspect: "Evolution or development, in their [*sic*] noblest and fullest signification, may spiritualize nature, ennoble man, and honor God. The evolution which we criticise is a composite of scientific theories—some true, others doubtful, and others false—which are held together and wrought into a fanciful philosophy by the very slenderest threads of analogy, and elevated into a negative theology by a daring flight of professedly modest or agnostic reserve." Recognizing that this "fanciful philosophy" is made up of several distinct elements, the critic announces that he will take up these in the order of their production and show their genetic connection. To our great surprise, after reading this declaration, we find that the following is the order in which the "elements" in question are placed:

1. Darwinism, as applied to contemporary species.
2. The same extended into the region of paleontology.
3. The arguments drawn from biological study.
4. The doctrine of the conservation of force.
5. The doctrine of the development of the organic from the inorganic.
6. The extension of No. 5 so as to include the phenomena of sensibility among the developed products.
7. Its further extension so as to include the sense of personality.
8. The arguments drawn from the development of language and of human society.
9. The wider theory of cosmical development as suggested by the nebular hypothesis.
10. A materialistic interpretation of the universe.
11. Agnosticism.

How it could occur to Dr. Porter that this arrangement represents in any degree "the order of time and thought after which they" (i. e., the several elements of the prevailing evolution philosophy) "have successively come into form or being," we can not imagine. There is really not the least vestige of an historical order discernible. Instead of Darwinism being put first, it ought rather to have been put last. It was the apparent immutability of species that for a long time stood

in the way of the adoption of a general theory of development, which the labors of many men in different fields had been preparing. The ship was on the stays, prepared to glide into the ocean, when Darwin came and knocked away one or two of the blocks that had been most obstinately hindering her descent. The wonderful success of the Darwinian theory was chiefly due to this very circumstance, that so much had been already done to facilitate its acceptance. The doctrine of the correlation of force, to which Dr. Porter assigns the fourth place, was, if we date it only from the publication of Grove's treatise, seventeen years old when the "Origin of Species" appeared. The nebular hypothesis had been waiting for over a hundred years, or since the publication of Kant's "General History of Nature and Theory of the Heavens." The progress of society and perfectibility of human nature were the commonplaces of the last century, which was also thoroughly familiar with the discussion as to spontaneous generation, or the development of the organic from the inorganic. Why the arguments from biology should be separated from Darwinism proper it is difficult to see, considering that Darwin, from the first, based his theory of the origin of species on biological grounds, quite as distinctly as on the operation of the struggle for existence. It is Darwin, above all men, who has popularized the arguments from rudimentary organs and from the changing phases of embryonic life. Could Dr. Porter have made good his promise to describe to us the evolution of evolution, if we may so express it, he would have done a very useful work; but the fact is, he has not even attempted it, but has simply given us what, if we may be allowed for once to adopt a common misquotation of Horace, may very truly be called the *disjecta membra* of a philosophy.

Leaving this point, however, let us inquire what the author of the "Lecture on Evolution" has to say on the several heads into which he has divided the subject. In regard to "Darwinism," he finds the evidence for the transformation of species insufficient. He admits the tendency to variation and the struggle for existence; but does not see that these, alone or principally, determine the origin of species. One may go a long way with Darwin, he says, and yet fail to draw the conclusion that three or four original types have been the ancestors of all other organic forms past and present. This language is dubious. It might suggest that, had Darwin been a little more liberal with his archetypes, the learned doctor would have agreed with him fully. What is it "to go a long way with Darwin"? The mere recognition of the tendency to variation and the struggle for existence is not to *go* with Darwin at all: it is merely to accept his starting-point, and to recognize facts that were fully recognized long before his time. It is a pity that so doughty a champion of orthodoxy as Dr. Porter does not tell us more distinctly what his own position is. Apparently he rejects the theory of transformation by change of environ-

ment. Does he, then, believe in the theory of special creation? Was there no "becoming" for the forms we see? Were they suddenly flashed into existence by the Divine fiat, or did they struggle out of the ground like Milton's horse? There is little gained, from the strictly orthodox point of view, in holding aloof from Darwin's conclusion, on the simple ground of the insufficiency of the evidence, if you hold yourself prepared to accept it as soon as a little more evidence is tendered. If the theologian descends into the arena, it should be, not to declare that the Darwinian hypothesis is as yet unproved—a simple man of science, if he thought the facts warranted it, might do that—but to declare it, on *a priori* grounds, unprovable because false. When Theology can take this tone and make it good, she will be listened to; but, when theologians merely potter in science, there is really no special significance in their acceptance of this or their rejection of that scrap of scientific doctrine; what their opinion, one way or another, is worth, simply depends on the degree of their competency in relation to the matter under discussion. This is a point that should not be lost sight of; for a certain illusion is apt to be created when a professed theologian enters the scientific arena. He is popularly supposed to carry with him certain higher canons of criticism, to represent some authority that can traverse the decisions of science and hold them in check. It is important, therefore, to watch him and see what he does; and if we observe that he is merely making what use he can of his knowledge of the scientific elements of the case, and carefully keeping his theological commission in his pocket, we should attach no more importance to his intervention than if some scientific student or literary man of about equal knowledge of the subject had come forward to have his say.

In favor of Darwinism there is this to be said, that it deals with *veræ causæ*. It points to certain natural laws or conditions that visibly tend toward the variation of species, and it furnishes, in certain cases, almost conclusive evidence of the descent of different types from a common ancestral form. What, it may be asked, has theology done to render the world of organic forms intelligible to us? All the talk we now hear about a plan of creation and divine ideals is simply an attempt to give a theological complexion to facts that science has discovered, and that are found to be incongruous with the rude conception of creation hitherto current. In company with Darwin and Spencer we feel that we are at least on the road to sound and exact knowledge of the processes of development, to an understanding of how what is came to be as it is. In company with the theologian we quickly realize the hollow and formal character of the explanations he tenders. Except when he openly borrows the language and theories of science, he has absolutely nothing to tell us that our intellectual faculties can appropriate. If theology had a theory of the universe capable of entering into serious competition with the theory of evolution, then no doubt

the weakening of the latter might mean the (relative) strengthening of the former. But such is not the case: the theologian, as a theologian, can only say, "God made the world"; science alone can undertake to show how the work was accomplished, i. e., through what successive stages and genetic connections. If, then, the evidence for Darwinism, or for evolution generally, is not complete, all we can do is to wait until it is complete, or until *some* physical theory of things is established on solid grounds of evidence.

Not only is Dr. Porter himself persuaded that there is no conclusive evidence for the Darwinian theory; but he asserts that "the practical common sense of mankind and the sagacious tact of most naturalists has [*sic*] usually decided . . . that under the present conditions or laws of being, within the historic period, the limits of well-defined species have not been and are not likely to be changed." Evidently "the common sense of mankind and the sagacious tact of most naturalists" are very much on their guard. They don't want to decide anything rashly, so in delivering their opinion they stipulate for "present conditions" and "well-defined species" and "the historic period." Where they momentarily forget themselves is where they seem to stretch the historic period into the future, asserting that within the limits of that period "well-defined species are not likely to be changed." This is undoubtedly a slip on the part of the "common sense" and the "sagacious tact"; for a period can not be "historic" until it has had a history.

It is needless to say that Dr. Porter's opinion as to the unsatisfactory nature of the evidence for Darwinism is not conclusive. As he has appealed to the "sagacious tact of most naturalists," let us see what a naturalist and biologist of the highest order, the Rev. W. H. Dallinger, F. R. S., has to say on the question at issue in the very last number of the "Contemporary Review." These are the learned gentleman's words:

"The philosophical interpretation of modern biological knowledge which originated in Darwin, and has been universally received by trained and competent students, stands so securely that there is little need of additional facts to make it, so far as it is intended to reach, an immutable element, in all future time, in the interpretation of vital phenomena. Much may be added, but the philosophy of the 'Origin of Species' must remain. It is, however, a matter of the deepest interest and of much moment that the active investigations carried on by biologists all over the globe, not only give an unbroken stream of evidence coincident with the great law of variation and the survival of the fittest, but that, ever and again, facts of the largest import present themselves, that pour a flood of light, as unexpected as it is confirmatory, on this great biological law. It was a discovery of much philosophical value and biological interest, that the duck-bill and echidna were oviparous though mammals; this was a final confirma-

tion of what was before partially learned from their osteology and the little that was known of their embryological features, viz., that there must have been a root-stock out of which, in an unmeasured past, arose both the reptilia and the earliest mammals. But a new fact of even larger interest and carrying us inconceivably further back, taking us indeed, with something like clear light, to the origin of the vertebrates themselves, is presented to us by Mr. W. Baldwin Spencer, of the University Museum, Oxford. Mr. Spencer only presents the facts, but their bearing on the philosophy of evolution is apparently inevitable; and certainly they are inexplicable save by this hypothesis."

Then follows an account, for which we have not space, of the discovery, imbedded in the skull of a vertebrate animal, of an *invertebrate eye*—an atrophied organ, devoid of all function, but pointing to the conclusion, in Dr. Dallinger's words, "that the tunicates and the vertebrates arose in one stock of enormous antiquity." The above extract, however, is chiefly significant for the emphasis with which it asserts the dominion that the Darwinian philosophy has acquired over the minds of competent students of science, and the extent to which it is inspiring and directing their labors. In the face of such powerful testimony, how petty seems the quibble about "the sagacious tact of most naturalists" having decided that "within the historic period" the limits of "well-defined species" have not been changed! Whatever most naturalists may think on this altogether secondary point, it is abundantly evident that they accept the Darwinian theory as a whole, and make it a guiding light in biological research. Any one who wishes to see in what esteem Darwinism is held among men who occupy themselves with the study of organic nature need only turn to the proceedings of learned societies, and he will there see that Darwinism, or, as Dr. Dallinger happily expresses it, "the philosophy of the 'Origin of Species,'" is almost universally accepted as the starting-point of biological speculation. Its general principles will be found to be either tacitly assumed or expressly acknowledged, in nearly every contribution made to those sciences on which it has any bearing. How wide is the range of its application may partly be judged from the following summary, taken from "Nature" of October 23, 1884, of an essay read by Dr. Kirchhoff, of Halle, at the Magdeburg meeting of the Association of German Naturalists and Physicians, on the subject of "Darwinism and Racial Evolution":

"It was argued that the physical development of peoples was intimately dependent on the natural conditions of their respective surroundings. The inhabitants of northern lands are noted for a preponderance of the pulmonary functions; those of hot, moist, tropical regions for a more marked activity of the liver. Thus, the strongest lungs prevail among the Mexicans, Peruvians, and Thibetans, who occupy the three highest plateaus on the surface of the globe. . . . The daily pursuits of a people are constantly evoking special organic

peculiarities. This is shown most clearly in the keen sense of smell, sight, and hearing, observed in all hunting and pastoral tribes of the highlands and steppe-lands, as well as in the sense of locality and the surprising physical endurance under hunger, thirst, and other privations. . . . The principle of selection prevails in the moral as well as in the physical order. As mankind pressed northward, irrepressible spirits alone could sustain life under the depressing influences of bleak Arctic surroundings. Hence the remarkably cheerful temperament of the Esquimaux, who are also bred to peaceful habits; for peacefully disposed families alone could dwell under a common roof, as the Esquimaux are fain to do in the total absence of fuel. Through overpopulation the Chinese have become the most frugal and industrious of peoples, in recent times emigrating to foreign lands and crowding out all more indolent or pretentious races."

These are but a few examples of the changes which environment can work, in periods of time by no means unlimited. Yet Dr. Porter forbids us to believe that a changing environment, operating through periods of indefinite length, has wrought *specific* differences. What we *know* is that in past ages thousands of species have died out and given place to others; and the only question to be settled is whether the connection between successive forms was a genetic one or not. We can conceive the Creator as wiping the slate, so to speak, of his organic creation, and then covering it again with new forms more or less like the former, but having absolutely no connection with them, and as repeating this operation unnumbered times. The trouble with that conception is that it is a little too barren. It might serve for a postulate in theology, but there is no nourishment in it for the human mind. It dispenses with all cause save a formal and hypothetical one; it takes all meaning out of the universe. The world therefore prefers to believe with Darwin that the stream of life has been continuous, and that all existing forms of life have truly issued from those that preceded them; and the world is thankful to Darwin for having done something—nay, much—to show how the transitions from form to form may have been accomplished. He may not have solved the problem entirely—it is not pretended that he has; but thoughtful people in general feel more disposed to make the most of the indications he has furnished than to carp at the evidence as not being logically complete.

According to the learned critic, it is owing to a sense of the insufficiency of the evidence afforded by the paleontological record that the evolutionist resorts to the arguments from biology. Here comes in a remarkable bit of writing: "Perhaps it would be more fair to say, if he [the evolutionist] knew how to put his case in the strongest form, that he would urge that experimental proof is not to be looked for, but only indications of a peculiar character." This may be considered a perspicuous style of composition at Yale; but we confess to

finding it uncommonly cloudy. We remember, of course, that our author is not bound to furnish us with brains as well as with arguments; but, using such brains as we have, we venture to suggest that the substantial meaning of the sentence might better have been expressed in the following words: "Perhaps, if he knew how to put his case in the strongest form, he would urge," etc. We might then with less distraction have admired the modesty which offers to assist the Huxleys and Spencers, the Morses and Fiskes, to state their case in the strongest form, and also the curious felicity of the adjective "peculiar" as applied to the "indications" which the evolutionist, duly instructed by the ex-president, would say are to be looked for. A sentence or two further on we come across what may fairly be styled a "peculiar indication," namely, the word "protean," used in the sense of "most primitive," in the phrase "from the protean forms up to the human." Haeckel and other naturalists talk of the *protista;* and Dr. Porter apparently thinks that "protean" is the proper cognate adjective.

The biologist, we are told, "makes much of the existence of rudimentary organs in the higher species of animals, *and* which [*sic*], he contends, give positive evidence of a great number of intermediate members or links in the great chain of progressive development, which have left no remnants or traces behind." Does the biologist really talk in this fashion? We very much doubt it. How can these "intermediate members" have left no remnants or traces behind, if they have left rudimentary organs as memorials of their existence? Then what is the force of the word "intermediate"? Intermediate between what? A rudimentary organ simply points to some *anterior* form, in which the organ was better developed. The word "intermediate" has here absolutely no application. Our author is able, however, to give us the philosophy of the rudiments. It "can not be denied," he says, "that they prove a unity of plan or of thought, of beauty and order, in the production of the wondrous cosmos of animal life, including a dramatic order in the introduction of its families and groups." When people say that a thing "can not be denied," they generally mean that it must be admitted. If Dr. Porter uses the words in this sense, he simply closes the whole case without further argument. The same method applied to the question of evolution at large would have saved him the trouble of writing his lecture; though possibly a brief oracular announcement might not have wrought instant conviction in the minds of the Nineteenth Century Club. We are going to be very bold, for our own part, and insist on treating the question as still open. We say then that, in our opinion, Dr. Porter's theory of "a unity of plan or of thought, of beauty and order," is not tenable, and that the evolution theory alone meets the case satisfactorily. There is no use in talking of beauty or order, unless we mean such beauty and order as human faculties can recognize. Now,

our human faculties do not recognize beauty in the useless and dwindling rudiments of once-developed members. We are profoundly interested in the invertebrate or molluscoid eye of the vertebrate, *Hatteria punctata*, referred to by Dr. Dallinger, an eye "so buried in its capsule and surrounding tissue, and so covered with the skin of the head, as to make it almost inconceivable that it can be affected by even the most intense light"; but, if we are asked to admire the beauty of the arrangement, if we are summoned to recognize a wonderful example of order in the perpetuation of so functionless a structure, we hold back. The main element in beauty is fitness, the main element in order is purpose; and we see neither fitness nor purpose here. The only conceivable *purpose* would be to guide the biologist to the very conclusion he has arrived at, namely, that a remote ancestor of Hatteria was a mollusk; but, although as worthy, perhaps, of a few providential arrangements in his favor as anybody else, the biologist is not prone to think that such helps as he finds on the way were designed for his special benefit. He does not very well see how a past order of things could help leaving traces of itself; and he rests in the facts as they are.

Rudimentary organs, Dr. Porter assures us, bring more difficulties than aids to the doctrine of evolution. This is an extraordinary statement, seeing that competent biologists, almost without exception, have taken a directly opposite view. Does the learned doctor mean to say that biologists in general are radically incompetent to interpret the facts with which they have to deal—that facts which they ought to regard as subversive of a theory, or at least as throwing serious difficulties in its way, they accept with one accord as confirmatory of it? There is manifestly only one remedy for this state of things, and that is that the biologists of Europe and America should go to school to the ex-President of Yale, and learn from him how to read the book of Nature. Possibly, in that case, one of his bright scholars might ask him how it was, if the facts in connection with rudimentary organs brought more difficulties than aids to the doctrine of evolution, that he had himself declared, *in the very same sentence in which that statement was made*, that, were the doctrine of evolution satisfactorily established on other grounds, the existence of rudimentary organs *would be consistent therewith.** Then, perhaps, the class might be broken up. The scholars would, perhaps, not wait to hear the master discourse on embryology, and show how the successive stages of em-

* Here is the sentence—a remarkable one: "That they [rudimentary organs] would be consistent with the doctrine of evolution by favoring and continued environment, provided this were established on other decisive grounds, is also true; but they bring more difficulties than aid to this theory, inasmuch as the critic asks at once, If the movement of evolution were so wide-spread and long-continued, why are not these broken links more numerous?"—(Lecture, p. 10.) We fail to see the propriety in calling rudimentary organs "broken links."

bryonic life may be interpreted as a kind of "logical growth" or the development of a plan. The difficulty with this interpretation, again, is that it is merely formal and means nothing. If a Divine plan is to be invoked on every occasion as the explanation of whatever is obscure, all rational inquiry is at an end. God is not bound to give reasons. His ways are past finding out. Nature's ways, on the other hand, do lend themselves to progressive interpretation. There are ultimate questions that always elude us, but we can learn through experience and observation to connect cause and effect, antecedent and consequent. It is upon this line that the scientific investigators of the day are working; and not a day passes without bearing witness to the fruitfulness of their methods. This is the reason why, among scientific workers, an hypothesis that lends itself to verification, that deals with the actual and real, is always preferred to one that supplies a formula and nothing more.

We pass over, as containing little or nothing that is relevant to the subject of evolution, Dr. Porter's discussion of the doctrine of the conservation of energy. The next section of the lecture deals with the theory that the phenomena of life may be highly specialized and complicated forms of mechanical (molecular) action. "To put forward such a theory," says Dr. Porter, "is to hypostatize an agency or an agent of the vaguest and most nebulous character, and to claim for it all the attributes of things or agents that are known to exist under the severest tests of observation and experiment." We wish Dr. Porter would explain how it is possible to hypostatize an agent of the most nebulous character and yet assign to it a most definite character. The theory under consideration simply proceeds upon the principle that to simplify or explain you must generalize—that is to say, you must find the means of expressing the special in terms of the general. The phenomena of life are highly special phenomena, and we are naturally led to wish to see them in wider relations. To rest in the special is to rest in nescience; and the awakened human mind does not consent to that. The widest relations of all are those which we call mechanical; the natural tendency of thought, therefore, is toward the belief that it is through the compounding and recompounding of these, in ways and regions at present far beyond our ken, that matter acquires its higher and more specialized functions. We see in the human body what a mere aggregation of cells may become; we see in human society what a mere aggregation of individuals may become; and it is impossible that Science should not seek her equilibrium in some theory of the essential unity of all forms of matter and all modes of force. We must, however, quote a powerful sentence which in the lecture before us immediately follows (page 15) the words last quoted: "To apply induction to a process which ought to begin with analogy and end with fact, but which begins with a surmise and ends with a dogma, is to reverse the order and to deny the criteria which have given Science

her authority to prove and Philosophy her power to prophesy." This has a most magisterial and academic sound; but oh! will somebody please to say what it means? The oracles of old were often of doubtful import; the trouble with them was that they admitted of too many interpretations. But the trouble with the oracle before us is that, to our finite comprehension, it does not admit of any interpretation. How can *induction* be applied to a *process?* Induction is itself a process. Again, how can the application of induction to a process (admitting the thing possible) constitute the reversal of an order? Should the process be applied to the induction instead? What, we fancy, Dr. Porter meant to say was, that a certain process, which he tries to describe, reverses the order and denies the criteria, etc., *not* that the application of induction to the process has that result. But who should be able to say what he means in clear and unmistakable language if not an ex-President of Yale? The fact is, however, to return to the main question, that the criteria of science are not denied, nor is "Philosophy" robbed of any power she ever had to prophesy, by the hypothesis under consideration, which is constructed, as we have tried to show, strictly in accordance with established analogies. There are just two courses open to us: one is to assume, with each advance in the complexity of phenomena, the introduction of some new force wholly unlike and unconnected with those manifested in simpler phenomena; the other is to assume that all force is one, and that it is merely the progressive compounding of the simplest relations that yields the successively higher functions and products. Men of science in general incline to the second alternative rather than to the first.

"In spite of our cautions," says Dr. Porter, "evolution will take another step upward, even though it plant its ladder in the clouds and lean it against the sky." How are we to explain such daring perversity on the part of "evolution"? Could it be that Dr. Porter's cautions are not understood? There are phrases and sentences in the pages before us which really suggest an excuse for evolution on this score. What, for example, does this mean: "The unfeigned gratitude in the presence of others, or their displeasure, is soon fixed in the brain reactions"? If we thought the context would throw any light on this remarkable utterance we would quote a certain amount of it; but we have carefully scrutinized it ourselves without getting any help. Dr. Porter is here assailing the evolutionary view of ethics, but that he adequately understands it is not very evident, in spite of the profuse use he makes of technical phrases. We find no reference in his argument to the development of social morality through domestic—to the origination of morality, according to Herbert Spencer, who is perhaps as authoritative an exponent of evolution as could be named, through the care for progeny. If Dr. Porter had really wished to do justice to this part of his subject, he should certainly have taken full account of the line of argument followed out in the "Data of Ethics."

He probably would not then have written the following awkward and pointless sentence: "The altruistic experiences which somehow find themselves within the arena of man's private experience naturally secure to themselves the response of man's interested gratitude; selfishness awakens a natural antipathy." Surely the word "experiences" here should be replaced by "sentiments." Imagine "experiences" securing a "response of interested gratitude"! Then, what is meant by qualifying gratitude as "interested"? We imagine that it is of the nature of gratitude to be interested. The main point is, however, that the evolution philosophy *does* explain, if not to Dr. Porter's satisfaction, to the satisfaction of many, the origin and growth of altruistic sentiments, and that it is not correct, therefore, to speak as if that philosophy wholly failed to grapple with the question.

It is remarkable how free the ex-President of Yale seems to feel himself to treat *de haut en bas* the leaders of modern evolutionary thought. He twitted them, it will be remembered, with not knowing how to state their own case to the best advantage. He now talks of "the dreary and meaningless theories" of Spencer and Lewes, and smiles at the "*naïveté*" of Spencer in acknowledging that he had found the germ of his system in the philosophy of Wolff. Then of Spencer's application of Wolff's idea he says, "There never was a profound spiritual truth more ignominiously misinterpreted and more basely perverted to earthly uses." We should like much to see the evidence that Spencer had misinterpreted Wolff. According to Dr. Porter, to misinterpret a writer is apparently to accept some thought contained in his writings, but to develop and apply it differently from what he had done; and to confess the obligation is "*naïveté*"! Really, the ex-president is teaching us some strange lessons.

Perhaps he (Spencer) "was incapable," our critic haughtily remarks, "of discerning the difference between a homogeneity in matter, necessarily and blindly tending toward a heterogeneity, and such a law of organism [*sic*], progress, and growth as requires a spiritual intelligence to originate and maintain it." Perhaps he was, poor man! or perhaps he thought he had better discern and formulate progress where he could do it to the best advantage, and leave the postulating of spiritual intelligences to those who had a greater talent than he for building in the region of the unverifiable. It would have been "far more creditable" to Spencer, Dr. Porter remarks, if he had taken the pantheistic theory for better or for worse, in lieu of his own conclusion in favor of an Unknowable Cause of all things. It will occur to some, we think, that Herbert Spencer's "credit" is quite as safe in his own keeping as it would be in his critic's.

Let us, hasten, however, to the conclusion of the whole matter. Dr. Porter's final position is that "evolution, as a consistent theory, in its logical outcome will be found to give a material substratum and material laws for the human spirit; to involve caprice in morality,

tyranny in government, uncertainty in science, with a denial of immortality and a disbelief in the personality of man and of God." Here we distinctly join issue. Evolution, as taught by Herbert Spencer, does nothing to weaken the fundamental distinction between subject and object, between mind and matter. If Spencer teaches that both these aspects of existence may, or rather must, find their union and identification in the Unknowable Cause, he does no more and no less than the Christian, who believes that God is the author both of the visible world and of the human spirit. Evolution gives material laws for human thought, only in so far as it shows the dependence of each higher plane of life on those below it; but, inasmuch as it also shows the reaction of the higher on the lower, it does as much for the establishment of liberty as for the demonstration of necessity. As to involving caprice in morality, that is precisely what it does not do, but what theological systems, referring the criterion of right and wrong to a personal will, always have done and always will do. The proof is simple and conclusive. Wherever morality has disengaged itself from theology, there it has shown a tendency to develop along the same lines. Wherever it has been complicated with theology, there it has always been more or less incalculable and capricious; we may add, more or less perverted and debased. As to tyranny in government—the thing is almost too preposterous to discuss—every child knows that the days when evolution would have been treated as a damnable heresy, to be extirpated by fire and sword, and when a spiritual philosophy was supreme, were precisely the days of the most odious political tyranny; and that to-day, step by step with the advance of the philosophy Dr. Porter so much detests, political administration is becoming milder and more equitable. "Uncertainty in science"—what are the proofs of it? Was there ever a time when science was surer in its methods, or more fruitful in its results, than it is to-day? What did the spiritualistic philosophies of the past ever do for science except to embarrass it with arbitrary hypotheses, and to stand in the way of the recognition of the natural causes of phenomena? Did it help the understanding of disease to explain it as a chastisement for sin? Was the old doctrine of demoniac possession—so strongly countenanced, unfortunately, in the New Testament—an aid toward the scientific treatment of insanity? Did the general belief in ghosts and devils help to rationalize men's thoughts? We think that answers should be given these questions before we are asked to accept the statement that the doctrine of evolution will lead to "uncertainty in science." The fact is, that the hold which evolution has to-day upon the scientific world is due principally, as Dr. Dallinger observes, to its proved utility in a great many different fields of scientific investigation. The man of science, we may be sure, will not be slow to discard it, when he finds it beginning to lead him astray and vitiate his scientific labors.

Finally, as to the relation of the evolution philosophy to the belief in immortality and in a personal God. When Darwin was asked by some one whether his theories were consistent with faith in Christ, he answered that they had no bearing upon faith in Christ, except in so far as they might render those who adopted them exceedingly careful as to the evidence for any belief or opinion presented for their acceptance. The answer was a good one; and a somewhat similar answer may serve us here. The doctrine of evolution is simply a mode of conceiving and accounting for the succession of events on the earth. It is in no sense a metaphysical or ontological doctrine, and lays no claim to the absoluteness with which metaphysical and ontological doctrines are invested. It does not pretend to penetrate to essences or to unveil final causes. If it is regarded by some as solving all mysteries, that is simply because they do not adequately understand it. Mr. Spencer certainly has never given countenance to such an idea. It does, however, as Darwin said of his philosophy, call constant attention to the need for proving all things. It strikes at the idea of authority, always excepting the constitutional authority, as we may term it, of demonstrated truth. What is troubling the theologians to-day is that it is making good the claim advanced by Christian Wolff for philosophy, namely, that it should embrace the whole domain of knowledge. There may be a great deal of wild talk about evolution on the part of people whose ideas on the subject are crude and superficial, just as there is a great deal of wild talk about art and about politics among people who know next to nothing of these subjects. Nevertheless, one good effect is everywhere apparent—the growing demand for proof in lieu of dogma. Now, the doctrine of immortality is just in this position, that, heretofore, it has been accepted upon authority—upon the same authority as that upon which the most preposterous fables have been given out as solid truth. That authority is discredited, and among the intelligent classes is becoming more so from day to day. The doctrine of immortality, therefore, has to seek out new proofs; and up to the present it is still engaged in the quest. That an emotional longing for immortality is common among men is no doubt true; and, if that is a ground for believing in it, then the case may be considered proved. Those upon whom the methods of modern science have taken hold will probably ask for more conclusive demonstration.

The idea of God, again, is compromised to some extent in the same manner as the doctrine of immortality, namely, by the discrediting of the authority upon which it has been taught. It has now to maintain itself in the open field of philosophy. To say that it is found in the Bible, and is to be believed because it is there, is no longer sufficient. In the present state of thought, the belief in God must be borne in upon the human mind, as the result and consummation of all its activities, or it will certainly lose ground. If Dr. Porter can teach, with

power and demonstration, a philosophy that will place the belief in God upon unassailable ground, not only will he encounter no opposition from evolutionists, but he will, we undertake to say, receive their hearty thanks for removing out of the way a question which, though not properly belonging to their field of thought and labor, has too often been made use of, maliciously or ignorantly, for their annoyance. It is needless, we hope, to say that the demonstration would in no way affect the practical work of scientific investigation. The constancy of natural law is the one essential condition of scientific progress; and, that datum remaining, men would still seek to know what is in the present and what has been in the past; and would still regard the world as Wolff regarded it, as "a series of changing objects which exist conjointly and successively, but which are so connected together that one ever contains the ground of the other."* Dr. Porter does not himself seem to be of a very different opinion, for (page 31) he sees no objection to "connecting the scientist with the original star-dust," so long as we consent to do so through "the progressive complications of a slowly developed thought of the living and loving God." If Dr. Porter really understands how the progressive complications of a thought could facilitate the conversion of star-dust into a scientist, he stands on a proud intellectual eminence; and it is no wonder if he feels that he could school the whole evolutionist tribe, from Darwin and Spencer down. It is, however, going a long way with the evolutionist to believe that, by the aid of a few thought-complications, the star-dust could be brought to take so improved a form; and the evolutionist will not quarrel with him for his proviso. The evolutionist does object, however, when he is told that certain "artificial lines of progressive evolution may become luminous with thought when projected against the bright background of the living God." He says: "No; things do not become luminous when placed against a bright background; they become dark."†

Had we space we might notice some, no doubt unintentional, misrepresentations of Mr. Spencer's philosophical position, particularly in regard to his alleged demand for "faith." We must leave this undone, however, in order to make a few concluding remarks. Dr. Porter, we are sure, can not but feel that the present time is a critical one. The numerous attacks that have lately been made upon the theory of evolution, and generally upon the rationalism of the age, show that the defenders of ancient opinions feel that something must be

* Schwegler, translated by Seelye.

† The evolutionist is also driven to wonder what can be the state of English composition at Yale when the ex-president, in what was meant to be the most impressive part of his lecture, writes as follows: "Why, then, may he [man] not be worthy of the constant care and fatherly love of Him who has had him in His thoughts from the beginning till now, and *toward whom* His plans and movements have ever been tending?"—(Lecture, p. 32.)

done, or all the world will go after the new lights. Well, we too are profoundly convinced that something must be done. We have, on the one hand, ministers of religion and doctors of divinity denouncing modern science as godless; we have, on the other hand, men of science showing by their practice, if not by words, how little weight they attach to clerical objurgations. The priests proclaim that the dominant scientific philosophy destroys the sense of moral obligation; nay, more, destroys the ground of moral obligation. The scientists reply, in effect, that their philosophy is true, and that moral obligation must take care of itself. The situation is dangerous. It is a dangerous thing to tether moral obligation to outworn creeds; and it is an almost equally dangerous thing to formulate new principles of scientific inquiry, without clearly and frequently exhibiting the provision they make for the regulation of conduct. On the part of the theological world, there has been too much of frowning opposition to inevitable change; on the part of the scientific world too much gayety of heart in setting out for new destinations. The theologians have, for the most part, repulsed as a foe what they should have hailed as a friend; and the scientists have not shown quite enough consideration for the weaker brethren to whose convictions their new speculations were giving a shock.

We think, therefore, that there has been error on both sides, and that it is now high time the whole matter should be considered, as it were, in joint committee. The word has gone forth: morality must stand on a basis of natural law, or it can not stand at all. God can not make morality. He has to be moral Himself first before He can even sanction it; and, if we know God as moral, we know morality apart from the idea of God. The problem of the day, therefore, is the formulation and enforcement of a natural morality—a morality resulting from the nature of man and the conditions of his existence. We have to look the Universe in the face and question of it what it would have us do; that is to say, on what terms the harmony and happiness of human life are to be won. Heretofore men have trusted to names—to Moses and Manu, to Jesus and Buddha, and have received, at the hands of these, laws that were in reality the embodiment of human experience; but the time is coming, yea, now is, when law must take on an impersonal character and be obeyed as law. There is no uncertainty as to the fundamental principles of morals; but we have weakly allowed ourselves to think that the authority of all moral teaching is bound up with certain traditional doctrines. That is the cardinal error which earnest men should strive with all their power to banish. If there are signs among us of a relaxation of moral discipline, they can be accounted for, we think, by the fact that moral instruction has been becoming, for some time past, less and less a domestic matter, and more and more the function of a professional class. It was not through any professional class that Moses proposed to provide for the moral educa-

tion of Israel. "These words that I command thee this day shall be upon thine heart: and thou [not the minister or the Sunday-school teacher] shalt teach them diligently unto thy children, and shalt talk of them when thou sittest in thine house, and when thou walkest by the way, and when thou liest down and when thou risest up." How little this is done in Christian families to-day may be gathered from President Seelye's recent article in "The Forum," where he urges the utter insufficiency of the domestic teaching of morality and religion as a reason why the State should take the matter in hand. If, therefore, ex-President Porter and President Seelye, and all the other great educators of our time, want to render a signal service to the State, let them unite in earnest and continued efforts to revive the domestic teaching of morality. Let them strive to persuade Christian parents that it is more important for their sons to be honest than to be rich; more important for their daughters to be pure-minded, rational, and womanly than to be fashionable; and there will soon be a wonderful change in the moral tone of society. But so long as men like these stand apart, thundering against the methods of modern science, and representing moral authority as inseparable from supernatural creeds that are daily becoming more difficult of acceptance, so long will a very hurtful degree of uncertainty as to all moral law prevail in the community. The only escape from a situation that really threatens moral anarchy lies in the recognition of the fact that the Universe, as related to man, has lessons to teach; and that these, revealed as truths of reason to the mind and conscience, are not less authoritative than if thundered on affrighted ears from the cloud-wrapped summit of Sinai.

GENIUS AND PRECOCITY.

By JAMES SULLY.

II.

Men of Science.—Instances of astounding precocity do not fail us when we leave the more romantic walks of art and letters for the austere region of science. Mathematical genius and original power in physical research have alike been frequently heralded by exceptional boyish endowment.

Among the greatest discoverers we have instances of juvenile distinction. Galileo showed remarkable aptitude from earliest childhood. His favorite pastime was the construction of toy machines. A passion for music did not seduce him from his supreme devotion to mathematics, and by nineteen he was making important discoveries. Tycho Brahe illustrates the same early bent in a slightly different way. His devotion to astronomy had to contend, not with his own, but with

others' inclinations. Sent to read law at sixteen, he managed, after the day's studies, to pursue his astronomical observations, passing whole nights in his favorite occupation. Newton, like Galileo, occupied his playhours at school with constructing model machines (water-clock, windmill, etc.). By the age of twenty-three or twenty-four he had conceived roughly his chief epoch-making discoveries. Another English investigator, Thomas Young, was a striking example of precocity. He read with fluency at two. He showed extraordinary avidity of mind in very different directions, now busy mastering the difficulties of Oriental languages, now set on constructing a microscope for himself. His mind, unburdened with its weight of learning, was nimbly tracking out new truths in optics by the age of twenty-nine.

Recent English biography supplies us with two of the most signal illustrations of the precocity of the mathematical mind, viz., Clerk-Maxwell and Sir William Rowan Hamilton.

Among naturalists, too, examples of well-marked if less astonishing precocity are to be met with. Linnæus as a boy showed so decided a bent to botany that, through the advocacy of a physician who had remarked the early trait, he was saved from the shoemaker's shop, for which his father had destined him, and secured for science. At the age of twenty-three we find him lecturing on botany, and superintending a botanical garden, and at twenty-eight he begins to publish his new ideas of classification. Cuvier's history is similar. A poor lad, he displayed an irresistible impulse to scientific observation, and by twenty-nine published a work in which the central ideas of his system are set forth. Humboldt, again, showed his special scientific bent as a child. From his love of collecting and labeling plants, shells, and insects, he was known as "the little apothecary." At twenty he published a work giving the results of a scientific journey up the Rhine. In medicine, Haller is a notable instance of precocity.

Since Science has academical and other appointments to bestow on her distinguished votaries, we may estimate the precocity of scientific men by noting the early age at which such posts have been won. Laplace was mathematical teacher at a school when a mere lad; Lagrange was professor at eighteen; St. Hilaire at twenty-one; Kepler, Euler, Linnæus, and Davy at twenty-three; Cuvier at twenty-six; Copernicus at twenty-seven; and Tycho Brahe at twenty-eight. Others have obtained academic honors at an early age; among these, Lavoisier, Lyell, and Clifford.

Following our general plan, we have to ask what proportion of eminent *savants* have shown signs of precocity. I find, after going through a list of thirty-six, that twenty-seven, or three fourths, have given distinct evidence of a bent to science before twenty. Of the remaining nine, five appear to have first taken to science after this age, while in the case of four the question is left doubtful.

Looking now at the age of productivity, we obtain the following

results: out of a list of thirty-one, seven certainly wrote memoirs or other works under twenty; fifteen gave out their first known production between twenty and twenty-five; three began to write between twenty-five and thirty; leaving six who, so far as I can judge, entered on the productive stage after thirty.

If, again, we ask at what age fame, or the achievement which entitles to fame, is reached, we obtain the following figures: Out of a group of thirty-seven, fourteen reached this point before twenty-five, twelve between twenty-five and thirty; eight between thirty and forty; while three did not rise to the height of renown till after forty.

In science, as in the more serious department of letters, fame is sometimes reached suddenly by the production of a great work, the fruit of many years of study. Harvey's publication of his great discovery at the age of fifty is a case in point. It is to be remembered, however, that Harvey had expounded his theory in lectures some twelve years before this date. And the same kind of remark applies to Darwin and others who first gave to the world epoch-making truths at a somewhat advanced age; we commonly find that the actual discovery dates from a much earlier period, the promulgation of it being deferred till it was ready to be presented in a definite and verified form. The case of Franklin making his first, and this a capital, scientific discovery toward the age of fifty is, so far as I can gather, exceedingly rare, if not, strictly speaking, unique.

Philosophers.—If philosophy precedes science in the historical development of the race, we need not wonder at meeting with instances of youthful speculative genius. Coleridge is not the only case of a lad of fifteen having his head seething with metaphysical puzzles. But Coleridge, it may be said, never developed into an original thinker; and what we require is proof of the early manifestation of genuine philosophic originality.

Passing by the romantic story of Abélard dazzling Paris and Europe with his dialectics at the age of twenty, and coming to the modern period, we note that the most conspicuous instances of philosophical precocity are supplied by the history of British philosophy. Berkeley, as his commonplace-book shows, hit on his new principle of idealism at college when only eighteen, an instance of metaphysical audacity to which there is no parallel. His "New Theory of Vision," perhaps the most epoch-making work in the history of psychology, appeared when the author was twenty-four. His immediate successor, Hume, displayed speculative ability when very young, and was regarded by his mother as an "uncommon wake-minded" lad. His "Treatise of Human Nature," probably the work of modern times which has proved most stimulating to further inquiry, was thought out between the ages of twenty-three and twenty-six. And, oddly enough, Hume's most distinguished follower, J. S. Mill, has supplied the best recent example of philosophic precocity.

Among foreign metaphysicians, the two who come nearest to the above are Leibnitz and Schelling. Leibnitz was, like Mill, a prodigy of youthful learning, and began from the age of seventeen to write on a variety of subjects. His bent to philosophical reflection betrayed itself at the age of fifteen, when, at the University of Leipsic, he was entertaining the idea of rejecting the scholastic doctrine of "substantial forms." His first philosophical publication was the "Bachelor's Dissertation," which falls in the eighteenth year. But, after this, Leibnitz abandoned philosophy in favor of politics; so that he did not attain the rank of a great philosophical teacher till the age of forty-four. Schelling, if a less remarkable example of omnivorous learning than Leibnitz, is a more signal instance of precocious metaphysical constructiveness. He graduated at the early age of sixteen, taking "Myths" as the theme of his dissertation. He had written three philosophical works before the completion of his twentieth year.

Following the same plan as before, I have tried to determine the proportion of the precocious to the non-precocious among thinkers. Taking thirty-seven eminent representatives, I find that twenty-five, or about two thirds, appear to have shown a marked philosophical inquisitiveness before the age of twenty.

If now we go on to ask at what age philosophic production begins, we arrive at the following results: Among thirty-six, two wrote on philosophical subjects before the age of twenty; eighteen between twenty and thirty; eight between thirty and forty; and eight after forty.

Finally, with respect to the age at which greatness reveals itself in a remarkable achievement, we gather the following data: Out of thirty-five, three distinguished themselves before twenty-five; four between this date and thirty; fourteen between thirty and forty; six between forty and fifty; and eight after fifty.

Of those who achieved philosophic distinction after fifty we have no less illustrious names than Descartes, Hobbes, Locke, and Leibnitz. It may be added that Kant very nearly falls into this category, his first independent treatise appearing at the age of forty-six. The lateness of achievement in many cases is connected with the circumstance that other subjects, as mathematics, have been taken up before philosophy.

In presenting these statistics of genius, I am not unmindful of the defects of the evidence. Thus, for example, there are the gaps in the record of the childhood of great men which all the industry of recent biographical research has not been able to fill up.* Even where we do know something of the early life, we can not be sure that we have

* I have found the determination of dates in the case of the Italian painters particularly difficult for this reason. Old Vasari, in his "Lives," is very chary of figures, and, when he does venture on a date, he is very far from trustworthy.

a full and accurate account of the intellectual and moral idiosyncrasy. For, on the one side, there is the inability of parents, etc., to recognize the marks of natural distinction. But few gifted children have been privileged to have their sayings and doings observed and treasured like Clerk-Maxwell or Rowan Hamilton. On the other side, something in the way of overstatement must probably be set down to the exaggerative influence of family affection, and also, perhaps, to the action of the mythopœic impulse in endowing those who have attained greatness with a worthy origin in the shape of a distinguished childhood.

Since these two sources of error tend in opposite directions—to an underestimate and to an overestimate of the indications of precocity—we may perhaps assume that they roughly counterbalance one another. And, so far as there is any appreciable residual error, it would seem to be in the direction of understatement of the case.

We may now inquire into the meaning of our figures, and the conclusions to be drawn from them.

A glance at our different lists will show that throughout precocity preponderates. This will be made more apparent by the following figures: Taking the seven lists together, I find that of the cases examined 231 out of 287, or about four fifths, displayed talent before the age of twenty. The instances of those who gave no sign of their high destiny in their youth must accordingly be regarded as exceptions to the general rule.

I may add that these exceptions, or, to be more accurate, these apparent exceptions, include only one or two names of the first magnitude. I doubt, indeed, whether one could find in the lists of musicians, artists, and poets, a single clear instance of a man of supreme genius having failed to give these early indications.

In the second place, our inquiries teach us that in the large majority of cases the productive period of genius begins early. Thus, in a total of 263 cases, 105—i. e., just two fifths—are known to have produced works before twenty; or 211—or more than fourth fifths—before thirty. At the same time these figures plainly show that there is less uniformity in this particular than in the other.

In the third place, we gather from our investigations that a large majority of great men gain their first considerable success in early manhood. Thus, out of 258 cases, 101, or nearly two fifths, reach this point before twenty-five; and 155—in all about three fifths—before thirty. But the proportion of exceptions becomes decidedly larger here. Thus we have thirty-one instances, or nearly one eighth of the whole, only attaining distinction after forty. And among these are names of very high, if not the highest, eminence.

It follows that there is only a general and not a perfect consilience with respect to the different marks of precocity here selected. The

men who disclose the germ of a great intellect in boyhood are, as a rule, early in production, and in the attainment of an assured place among the great. At the same time, there are noteworthy deviations from this rule. Thus, Bach, Haydn, and Wagner in music, Perugino and Gainsborough in painting, Dante and Dryden in poetry, Cervantes and Scott in fiction, Gibbon and Niebuhr in scholarship, Copernicus and Darwin in science, and, finally, Descartes and Leibnitz in philosophy, are all instances of early promise followed by comparatively late performance.

The explanation of these facts seems to me to be the following: Genius, as the etymology of the word suggests, is essentially a native quality. A truly great man is born such. This means that he is created with a strong and overmastering impulse to a definite form of origination. And hence he commonly gives a clear indication of this bent in the first years of life. On the other hand, actual production presupposes other conditions as well. It implies, for example, a certain amount of physical vigor, a possession which many a son of genius has had to do without in the early years of life. Not only so, production on any considerable scale requires opportunity and leisure. And here the external circumstances become a matter of importance, as serving to further or to delay the process of achievement. For though it may be true that in the end real genius proves itself irresistible in its instinctive striving toward creation, every reader of great men's biography knows that parental disapprobation, aided by the necessity of living, from which even the most gifted of mortals is not exempt, has in a large number of instances greatly retarded the process of production and the attainment of distinction.

I do not, however, consider that these causes account for all the exceptions. After allowing for the effect of delicate health and external obstructions there remain a certain number of instances of late achievement which are only explicable as illustrations of a slow process of development. In a number of cases, the postponement of the fruitful effort has been due to the individual's own volition and not to external compulsion. Thus Dante, Milton, Cervantes, and others voluntarily passed their early manhood in active life, rather than in the life of imaginative creation, showing that the impulse to poetic creation was not at this period supreme and overpowering. In other cases, again, there is reason to suppose that the creative faculty unfolded itself slowly. What Macaulay says of Bacon is apparently true of more than one imaginative writer: the judgment developed in advance of the fancy. Defoe seems to be an example of such a late development of imaginative power, and George Eliot is a clear and very remarkable instance of this faculty first revealing itself at a comparatively late period. If to these considerations we add that men of genius vary considerably in their rate of production, that to many the process of creation is a slow, tentative progress, rather than a sud-

den achievement, we have, I imagine, a fairly complete explanation of the facts.

If now we compare the results in the different groups we reach other interesting conclusions. Speaking roughly, one may say that the numbers showing distinct promise before twenty in the several classes are represented by the following fractions:

	Musicians	$\frac{13}{20}$
	Artists	$\frac{8}{9}$
	Scholars	$\frac{4}{6}$
equal	Poets	$\frac{3}{4}$
equal	Novelists	$\frac{3}{4}$
equal	Men of science	$\frac{3}{4}$
	Philosophers	$\frac{2}{3}$

In order, however, to get a just idea of the relative proportions of the several classes, we must further compare them in respect of the date of the commencement of the productive period and also of the age at which distinction is attained. If we take work before thirty as representing early production, we find the proportions in the different groups to be approximately as follows:

Musicians	$\frac{1}{1}$
Artists	$\frac{11}{12}$
Poets	$\frac{11}{12}$
Scientists	$\frac{4}{5}$
Scholars	$\frac{6}{7}$
Philosophers	$\frac{6}{9}$
Novelists	$\frac{9}{16}$

Finally, with respect to the age of distinction, we learn that the following proportions attain this point before forty:

* equal	Musicians	$\frac{1}{1}$
* equal	Artists	$\frac{1}{1}$
equal	Poets	$\frac{11}{12}$
equal	Scientists	$\frac{11}{12}$
	Scholars	$\frac{9}{10}$
	Novelists	$\frac{4}{5}$
	Philosophers	$\frac{3}{5}$

It will be seen at once, on comparing these tables, that on the whole the order of the classes in point of precocity corresponds pretty closely with the order in which we have examined them. Musicians and artists stand at the head of the list throughout, and philosophers come last in two out of three of the scales. On the other hand, the relative position of the intermediate groups—poets, scholars, novelists, and scientists—varies considerably in the different scales.

Without attempting an exhaustive explanation of these figures, a remark or two may be hazarded as to the more potent influences at work:

* If we make twenty-five the limit, we find that artists just surpass musicians.

First of all, then, we note that the order in respect of precocity answers roughly to the degree of abstractness of the faculty employed. At the one extreme musicians and artists represent sensuous faculty, or the least abstract mode of mental activity, while philosophers at the other extreme illustrate the highest degree of abstraction. Between these come the men of imagination, the poets and novelists. And this is the very order we should antecedently expect from a consideration of the general laws of intellectual development; for sense, imagination, and abstract thought are the three well-marked stages of intellectual progress. Or, to express the same fact in physiological terms, one may say that the nerve-centers specially engaged in the production of sense impressions, mental images, and abstract ideas, develop and are perfected in this order.

Taking up the classes *seriatim*, one may say that the clear primacy of musical genius is probably connected with the fact that the faculty for music has, as its main ingredient, a very special and restricted sense-endowment, viz., a fine sensibility to tones and their musical relations, which, again, seems to be correlated with a special functional endowment of the organ of hearing. One may add to this that musical inventiveness presupposes no experience or knowledge of things, but merely an accumulation of tone-material.

Painting, like music, seems to depend on a special sense-endowment, viz., an eye for form and color, and also a finely organized hand, which endowments might be expected to be well marked from the first. On the other hand, it involves much more in the way of external observation and a knowledge of objects. Hence, perhaps, its inferiority to music in the matter of precocity.

Passing to men of letters, we find that, on the whole, poets are the most precocious class. Here, too, we note the presence of a clearly marked sensuous ingredient, viz., a fine ear for rhythm and the musical qualities of verbal sounds. The poetic endowment includes, moreover, as a principal act, or a lively, sensuous imagination, a faculty that is in a manner based on a certain degree of perfection of the senses, and so may be expected to become prominent at an early period of life. If to this we add that lyrical poetry is to a very large extent the expression of erotic and kindred feelings which are known to be developed in great strength during the transition from childhood to youth, we are able, I imagine, to understand much of the daring precocity of poets. It is to be remarked that, though there are several instances of boys writing comedies, dramatic composition begins as a rule considerably later than lyrical, and this accords with the fact that dramatic conception presupposes much more objective knowledge of men and things.

The next class to claim attention is the scholars. At first one may well be surprised to find these so high up in our first table, for the critical faculty, judgment, is known to be late in its development. But

the anomaly is only an apparent one. The scholar, the historian, and the critic are alike dependent on an exceptional power of acquisition and of memory, and this is well known to be a precocious endowment. Moreover, it is an endowment which is fairly certain to be duly noted, seeing that it is precisely the aptitude which is at the basis of school-renown. This is borne out by the fact that the class of scholars, etc., though high up in respect of early manifestation of ability, are not so distinguished in the matter of early production or of early attainment of excellence.

The next group in our combined scale of precocity is scientists. Their high place is, I believe, largely owing to the mathematicians. The mathematical faculty is well known to be a precocious one. The fact that it is often found in the company of musical capacity suggests that there is a common mental ingredient. In each we note the play of inventive imagination on a circumscribed mass of material easily acquired, viz., tone-images in the one case, and symbol-images in the other. On the other hand, the representatives of the natural sciences which involve prolonged processes of observation, etc., are much less forward.

The shifting position of novelists in our three scales is, perhaps, the most curious outcome of our investigation. Like the poet, the novelist employs as his chief mental implement the faculty of sensuous imagination. Hence the relatively high position in our first table. At the same time the novel presupposes much more in the way of knowledge of the world and reflection on its ways than the poem. Its most distinctive aptitude, perhaps, is a minute knowledge of character; a circumstance which brings it into close relation to one of the most abstract of the sciences, viz., psychology.

Respecting philosophers little need be said. That a considerable fraction should begin to write after thirty, and almost as large a proportion attain fame after forty, is just what one might antecedently expect. Indeed, nowhere perhaps is early achievement so truly marvelous as in the severe domain of abstract speculation. It is not a mere coincidence, I take it, that the two most brilliant examples of this precocity, Berkeley and Schelling, are metaphysicians whose writings are so deeply tinged with the glow of a poetic imagination.

In this attempt to explain our results we have confined our attention to the intellectual ingredient in genius. But we might also take into account the emotional and volitional factor—that is to say, the specific impulse which prompts and sustains the creative activity. And by so doing we might still further illustrate the general agreement between our facts and the laws of mental development. Thus, for example, the artistic impulse, which according to our tables shows itself to be most precocious, appears also to be the one first manifesting itself in a decided form in the history of the average individual, and of the race. The child and the race alike develop a crude art before they

take seriously to inquiry. How far this consilience extends with reference to the relative position of the several classes in our scheme I will not now venture to say.

Genius is precocious, then, in the sense of manifesting itself early. But what of its subsequent history? Does it soon attain the summit of its development, or go on improving as long as, or even longer than, ordinary intelligence? This, as was pointed out at the beginning of this essay, is, in a measure, a different inquiry, and one too long to follow out here. There are special difficulties, too, in pursuing this line of research. Although it is, in a general way, an easy matter to say when a man of genius produces his first distinctly original work, it is exceedingly difficult to determine how long he goes on improving. Critics are far from agreed, for example, as to the relative value of the earlier and later work of Goethe, Beethoven, Turner, etc. It may, however, be safely asserted that early manifestation of genius is not incompatible with a prolonged and even late development. Haydn, Beethoven, Michael Angelo, Titian, Milton, Goethe, Voltaire, Gibbon, Lessing, Newton, Leibnitz, Berkeley, Mill, and other great names, are examples of such a lengthy process of development. Indeed, there is much to support Mr. Galton's view that eminent men surpass ordinary men not only in superiority from the first, but also in a more prolonged development.*

Such a conclusion, it may be observed, would seem to accord with what we know of the general laws of mental evolution. For, if we compare the different races of man, or the different species of animals, we find that, in general, the higher the cerebral organization attained, the longer the process of development. Men of great original power, having the most highly organized type of brain, may be expected to illustrate the most prolonged movement of mental growth.

From this point of view we are able, I think, to see the difference between the course of development of a truly great intellect, and that of a precocious but stunted intelligence. That there are many clever children that never "come to anything," or, at least, do not fulfill their early promise, is a fact which nobody, probably, will deny. Some of these would perhaps have distinguished themselves if they had had better opportunities, or, at least, more ambition and energy of character. But, allowing for this, one finds a good remainder of youths who appear to have had a rapid but early arrested mental development. Such an early display of quickness, followed by a lengthy period of ordinary mediocrity, or even dullness, looks like a too great forwardness of ordinary human ability. In other words, the clever child is in this case not an exceptional being, but a quite average one, whose cerebral development has somehow outrun the common attainment of his years. He is like a tree that bears fruit too soon. On the other

* See "Hereditary Genius," p. 44. Mr. Galton has kindly sent me a fuller statement of his view on this point.

hand, the man of superb ability is precocious just because, having a finer brain to start with, he is raised above the average mental stature of his years. He rather resembles a tree which shoots at once above the surrounding trees, though it may mature and bring forth fruit later than they.—*Nineteenth Century.*

[*Concluded.*]

WOODS AND THEIR DESTRUCTIVE FUNGI.

By P. H. DUDLEY, C. E.

II.

AT the close of my former article I described the conditions which are favorable to the growth of the fungi on woods. In this article I present a few examples under similar conditions, to show what takes place as the result of such growth.

Fig. 10 is a representation of a typical example of decay at and below the ground-line of railway-signal and telegraph poles, sign and fence posts. In the case illustrated, as in a large number of other cases, the sap-wood forms part of the pole, the bark only being removed. At the ground-line the ever-present spores of some of the fungi have germinated, under the influence of the moisture, warmth, and air, and have sent out their delicate mycelia over the wood, the threads penetrating any season cracks or fissures, thence piercing and growing in the wood-cells; the manner of growth is not only interesting but wonderful, and almost leads one to think, for an instant, that the fungi, like animals, have instincts to protect them in their development. Certainly I do not wish to convey that impression, but rather to assert the fact of their certain growth and the consequent destruction of the wood, when the conditions before mentioned are present.

FIG. 10.

The figure shows a section from a telegraph-pole of black spruce (*Picea nigra*); the opening at the ground-line was sufficient for the admission of the necessary air to carry on the development of the mycelia and the fermentations, but not large enough to allow the wind and heat to dry up the moisture and check the decay; nor was the opening made until a long time after the internal decay was well advanced, the breaking away of the tissues of the wood occurring more from the inside than the outside. In unpainted poles especially of this wood so exposed to the sun that an exterior shell may be dried,

or in painted poles, the decay does not appear above the ground-line on the exterior until after the breaking away of the interior wood-cells. In chestnut poles, the sap-wood being so much thinner, the cells break away sooner than in the spruce.

From the place of growth at the ground-line the mycelia pierce the upright longitudinal cells more readily than they do those of the medullary system, growing up and down, but faster in the latter direction, from the fact that the moisture is retained below the ground-line in greater abundance than above. Accompanying the mycelia is a growth of ferments, either of the *Schizomycetes* (bacteria) or the *Saccharomycetes*, depending somewhat upon the particular fungi and the wood. These aid in carrying on the destruction by producing fermentations, which extend down the wood-cells preceding the growth of the mycelia. The illustration was prepared from a pole of which five feet in length of the base was in the ground, and decay had followed down the cells four feet, while above-ground the decay only followed up the cells a few inches; the pole being unpainted allowed the moisture to escape sufficiently to retard the upward growth. It will be seen from Fig. 10 that a few inches below-ground the exterior of the wood is not so quickly affected, and, comparatively speaking remains sound until destroyed from the inside, though retaining the moisture and facilitating the growth of the fungi. This illustrates one of the important principles to be observed in the care and preservation of our timber in structures, for it will be seen that exterior protection to unseasoned timber, or to that which is to be in a damp situation, retains the moisture and hastens internal decay.

In the case of painted posts above the ground the paint prevents the escape of the moisture, the mycelia and fermentations grow farther up the cells and the posts often break off on the inside above the earth, while appearing sound outside, with a cone-shaped fracture.

In Fig. 10 the decay was extending toward the center of the pole very slowly, the fermentation not being communicated with as great rapidity by the medullary cells, which are only one fifth to one third as large as the upright cells.

Fig. 11 shows the tangential section of the tamarack, which is quite similar to that of the black spruce. The three largest bundles of rays contain resin-ducts, while the cell-cavities of the rays can just be seen; also the sections of the lenticular markings on the walls; in Fig. 12, they show in position on the walls parallel to the medullary rays; the latter are the lines partly crossing the cut, and composed of short contiguous cells, which are thick-walled and not easily penetrated by the mycelia or destroyed by fermentations. An example of the slow lateral extension of the decay is found in the white cedar, a transverse section of which was shown in Fig. 2 (see August number). In growing trees of this wood some of the lower limbs often die, and, not breaking off close to the body, the fungi grow before the wound heals

and start decay in some of the upright wood-cells. Ties from such trees show decayed spots from one half-inch to an inch in diameter which extend through their entire length of eight feet. When the wounds close up, the decay is checked, and the wood is so durable that the ties are mechanically destroyed in the track before the decay spreads from the spots so as to render them unserviceable.

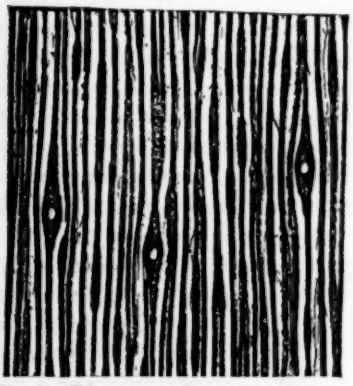

FIG. 11.—TANGENTIAL SECTION OF TAMARACK, $\frac{10}{1}$.

FIG. 12.—RADIAL SECTION OF TAMARACK, $\frac{10}{1}$.

The manner of decay shown in Fig. 10 is quite similar in principle to that occurring in double bridge-planks; where the under side of the lower plank is exposed to the air, a thin shell from one eighth to one fourth of an inch thick remaining dry, checks the evaporation from below of the absorbed moisture from above, and decay takes place from the fact that the necessary conditions for the fungi to grow are supplied.

A large majority of fence-posts, especially on railways, are from small timbers, with the sap-wood remaining except on the face side; on those of chestnut and oak, *Polyporus versicolor*, Fr., Fig. 8 (see August number), will often be found fruiting near the ground-line, as seen in the figure, while its mycelium has already partially rotted the post. Many other species of fungi will also be found fruiting, though in a majority of cases the mycelia only will be seen. The bark should always be removed from posts or timber to be used in the ground, otherwise it will furnish means for a growth of mycelia, and the posts or wood will decay much quicker than otherwise would be the case. This is readily seen in the forest; dead trees with the bark on will be found more or less covered with fruiting fungi, the wood decaying with great rapidity, while those with the bark off remain sound for a longer time. A striking object in a forest abounding in birch-trees is to see on their dead trunks, of twenty to thirty feet high, ten to twenty specimens of *Polyporus betulinus*, Fr. (Fig. 13), from one to four inches in diameter, projecting from small openings in the bark, which clasps around their

necks and holds them with firmness; it is a sight once seen never to be forgotten, for their presence shows the decay that has taken place, and conveys an impressive lesson. The bark, like the coat of paint on unseasoned wood, has retained the moisture, the mycelia have grown, and the tree will soon be destroyed and fall to the ground. A study of the decay of trees in the forests teaches many lessons of great importance, and in practice to avoid as much as possible the conditions which there conduce to decay. That the decorticated tree does not quickly decay furnishes a fact of general application in the care and preservation of timber, teaching that wood will be protected by paint only when it is thoroughly seasoned or dry, otherwise the paint will furnish the artificial bark and hasten instead of retarding decay. Readers who are conversant with the decay of freight-cars will understand what must be expected from the use of

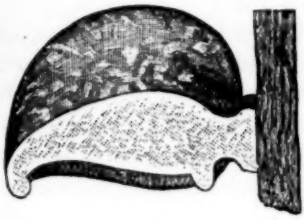

FIG. 13.

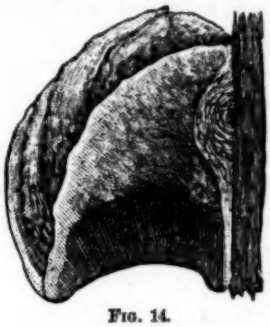

FIG. 14.

so much unseasoned lumber in their construction, and will comprehend the conditions furnished for the growth of fungi by the moisture inside of the cars retained by the outside paint. These facts must be more generally understood before the car-builder will be supplied with seasoned lumber. There lies before me as I write this a piece of timber from a building erected about eight years ago; to prevent the sills from decay, they were covered on three sides with asphalt, and tarred paper underneath the preparation; the wood was so badly decayed that they were replaced two years since. The wood was cracked longitudinally and transversely, the cracks being filled with the mycelia of the fungi which had destroyed it; upon drying, the wood crumbled to dust—the so-called "dry rot." Planks only two inches thick and eight inches wide were tarred on three sides at the same time, and were rotted under the tar over an inch in depth, while the unprotected side was sound. I did not see these timbers before they were treated, but they reveal their history as plainly as though the words were written upon them; the builder coated unseasoned wood, and produced the result he wished to avoid.

Fig. 14 is partly in vertical section, to show the pores in which the basidia grow bearing the spores.

On the under side of the various *Polyporei* here illustrated are the

pores, just visible to the eye in some species (see Fig. 6 in August number), from ten to twelve thousand occurring per square inch; others are coarser and not so numerous. Minute as are these pores, their interior is studded with the basidia and spores, a few of which, magnified four hundred diameters, are shown in Fig. 15, where *a* represents sterile cells and *b* the basidia, usually having four sterigma, each of them bearing a spore.*

Fig. 14 represents a very interesting but destructive type of fungi, and, in one sense of the word, parasitic upon living trees. It is drawn from *Polyporus fomentarius* (Fr.), "Dingy-hoof Polyporus." Pileus ungulate, sometimes four to five inches broad, sub-triangular, obsoletely zoned, nodulose, brownish-gray, resembling coffee slightly tinged with milk; its peculiar form and color make it easily identified. Closely allied to it are *Polyporus nigricans* (Fr.), Black-hoof Polyporus; pileus pulvinate; *Polyporus igniarius* (Fr.), Rusty-hoof Polyporus; pileus at first tuberculoso-globose (immarginate); *Polyporus fulvus* (Fr.), Tawny-hoof Polyporus.

The first three are found upon beeches, willows, hornbeams, cottonwoods, and plums, and trees of similar characteristics, and grow upon live trees, where they have been injured by the breaking of limbs, or by the checking of other limbs, at the junction with the trunk of the tree. *Polyporus fulvus* (Fr.) is found upon the firs. The mycelia,

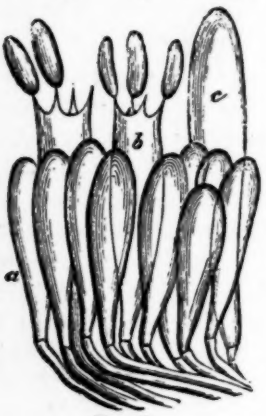

FIG. 15.

FIG. 16.

once started, will continue to grow in the heart-wood of the tree, while the sap-wood, with its bark, is still growing. If the wound is not closed by the growing tissue, the decay continues, causing hollows in the trees. These are not uncommon sights to those familiar with forests, and the trees almost seem to be conscious that they must keep their bark intact, or the invisible fungi will start and eventually destroy their stately proportions.

* From "Fungi: their Nature and Uses," by M. C. Cooke, M. A., LL. D., vol. xv of the "International Scientific Series."

A cut in a growing tree will be healed over in a few years, and in many woods, after twenty-five to thirty years, the scar can hardly be found. This fact will be recognized by those who have traced former land-surveys through the forests; upon rerunning the line, chopping into a supposed line-tree is often required to determine the question, the former wound having healed so perfectly as not to leave a scar.

Fig. 16, one fourth size, represents *Polyporus pinicola* (Fr.), partly in section to show the pores, also the apparent economy in the use of material in providing a surface for the growth of the spores, a succeeding forming over a preceding growth; on the upper portion the spore-bearing surface was renewed three times, and then new tissue pushed out underneath, and one set of pores formed before it was gathered. This fungus is found upon the firs and spruces, and is very destructive to planks of the latter, destroying those of two inches in thickness, in walks in from two to four years, while in station-platforms close to the ground, they do not last that length of time. One interesting feature in regard to this fungus is the quantity of phosphoric acid which was obtained from it by treating with necessary reagents. Potash and lime were also abundant. The watery extract from this fungus nearly resembles in composition the artificial preparations used for the cultivation of molds, and it undergoes fermentation in a few hours in the laboratory, cells of some of the species of *Saccharomycetes* growing in great abundance. In wood in process of destruction by this fungus, similar cells have been found.

The fungi so far illustrated are but a few of the species of the highest types which produce the so-called "dry rot" in timber, and the list could be extended, though the final results of all are practically similar, all requiring about the same general conditions for growth in order to destroy the timber. Besides those of the highest type, there are many other fungi, which are very destructive. The lower order of *Sphæriacei* contains some genera which are parasitic upon the trees, especially the *Sphæria;* others of its species thrive upon decorticated trees and unseasoned sawed timber, and many are associated with the decay of timber that writers have called "wet rot." The distinction from the improperly called "dry rot" is not clear, as in either kind the presence of moisture, air, and warmth combined is essential.

The mycelia of the *Sphæria* are not so abundant as those of the higher types, but the filaments are larger, stronger, and able to pierce the medullary cells of the sap-wood, destroying them and making a free entrance for air and moisture. Fig. 17 represents *Sphæria pilifera* (Fr.), as identified by Professor Charles H. Peck, and is drawn from specimens I have found abundant upon the sap-wood of the yellow pine from the South, as stated in the former paper; another form of it is sometimes found from the same locality, having smooth perithecia; this latter form is common in the white pine in Massachusetts.

The affected wood looks dark and moldy, and, upon close examination, the little beaks, about one eighth of an inch long, can be seen projecting from the wood, and, when it is dressed, will show discoloration; if dried, the further growth of the fungus is arrested, but will be resumed if the wood becomes damp. On examination with the microscope, the resin-ducts of the medullary rays (see Fig. 11) will be found filled with the dark-colored threads, spreading to the upright ducts and the wood-cells. Although the dark threads are abundant, discoloring the wood, they alone do not destroy the canals, but are aided by fermentations.

Fig. 18 shows some of the cultivated ferments I obtained from splitting open a block and touching a sterilized needle to a resin-duct destroyed by *Sphæria pilifera* (Fr.), and then inoculating a culture-tube of prepared gelatine. It will be recognized as a species of *Saccharomycetes*, but with more elliptical cells than *Saccharomycetes cervisiæ*, the yeast-plant. In wood further advanced in decay than the destruction of its resin-ducts, rounder cells have been frequently obtained by direct observation with the microscope.

Some species of the *Sphæria* played important parts, infinitesimal though they were, in inducing the fermentations which helped decay the Nicholson pavement; for in the partially decomposed white-pine blocks I find generally an abundance of the dark hypha, and, in some, the fragments of perithecia, showing it was a *Sphæria* that produced the dark filaments, and not a modification of the white mycelia of some of the higher fungi which are often found associated with it, or in other portions of the block. The decayed spots in the white cedar before described are more or less filled with the dark-colored hypha of some species of *Sphæria*.

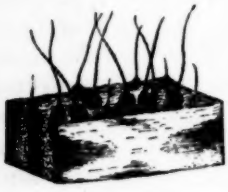

FIG. 17, ½.

FIG. 18.

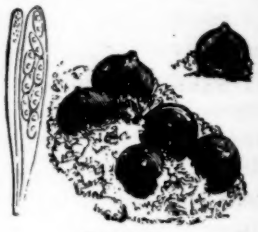

FIG. 19, 10.

Fig. 19, magnified ten diameters, represents *Sphæria aquila* (Fr.), "Brown nestling Sphæria," very common on limbs on the ground—the mycelium pierces and discolors the wood-cells. An asci containing the ascospores, magnified fifty diameters, is shown in the left side of the figure.

Sphæria morbosa causes the black knot in plum and cherry trees.

In Fig. 20 are represented a few of the filaments and the dark

* From "Fungi: their Nature and Uses," by M. C. Cooke, M. A., LL. D., vol. xv of "International Scientific Series."

spheres in the resin-ducts and wood-cells I found in some white-pine lumber from Michigan, used for sheathing freight-cars. The wood was discolored and the medullary rays were mostly destroyed, especially those containing resin-ducts, which were penetrated from the exterior, the hypha spreading to the longitudinal resin-ducts and wood-cells; upon drying, the decay was checked, but will commence again on moisture gaining access to the wood, which is likely to be the case in the cars. Such discolored wood should be rejected for all situations where moisture will again be possible, as it will quickly decay and communicate it to other woods. I recently saw a number of window-frames made up with lumber having on a portion of sap-wood which was discolored; the dampness from the stone window-sill, after a short time, will revive the former growth in the base of the frames, and, the exterior paint retaining the moisture, the growth will be facilitated, and cause decay of the wood.

Many of the ferments I have cultivated from some of the species of wood decayed by different fungi are dissimilar in form and manner of growth; some are confined entirely to a surface-growth of the gelatine, and others germinate in small spheres along the line of inocu-

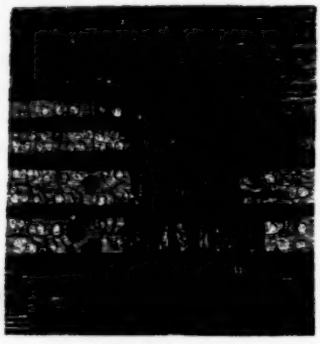

FIG. 20, $\frac{1}{1}$⁰⁰.

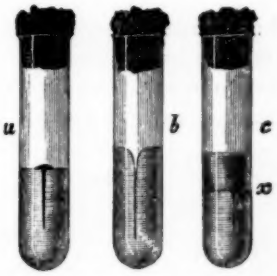

FIG. 21.—CULTURE TUBES WOOD FERMENTS. *a* shows nearly how those shown in Fig. 18 grew; *b*, those from decayed white pine; *c*, those from decayed hemlock.

lation, those nearest the surface only developing to any size, while those below the air-supply do not increase after a few days. The ferments obtained from decaying hemlock grew and liquefied the gelatine very rapidly from the surface downward; no budding ferments were found but those which grew by fission (bacteria) belonging to the *Schizomycetes*. An interesting and practical point was, that they grew rapidly in alkaline gelatine, while in that of acid they developed slowly; some cultures in the latter have not grown so much from the 1st of April to July 15th as the same kind of ferments did in alkaline gelatine in ten days after inoculation.

NOTE.—Figs. 21 and 22 are from "The Methods of Bacteriological Investigation," by Dr. F. Hueppe. New York: D. Appleton & Co., 1886.

The great abundance of germs in the air is well shown in attempting to obtain pure cultures of the ferments, as all the care and some of the methods of the pathogenic bacteriologist must be practiced. The fact of their universal presence is more readily demonstrated by growing them than can be done by the microscope alone, as one germ soon grows to a great colony, and to be seen singly may require staining to be differentiated by the microscope, so that it is likely it would have been overlooked in a specimen directly from the wood. The general dissemination of the spores of the fungi of the highest types by the wind has been mentioned; their invisibility like that of the ferments, however, eludes ordinary observation, and the bountiful supply of each, on every stick of timber, or the smallest piece of wood, is unnoticed.

FIG. 22.—INOCULATING A CULTURE TUBE.

Fig. 23 shows the spores of *Coprinus atramentarius* (Fr.), "Inky Coprinus," magnified one hundred diameters, which just enables the engraver to define their form. Many spores are much smaller and of different shapes, while the ferments found in the hemlock require enlarging to one thousand diameters to be as distinctly seen; what the latter lack in size is made up in quantity; and this it is which enables them to set up such destructive fermentations.

When decayed timber and ties dry, and crumble to dust, some of the ferments which caused their destruction will be disseminated by the winds, and each one can form a colony; not a stick of timber in the vicinity will escape a supply; drying at ordinary temperatures does not destroy, but only renders them inactive for the time being, and harmless until surrounded by the proper conditions for their germination. When these ferments fall upon unseasoned wood which contains from thirty-five to fifty per cent of its weight of moisture, many of them germinate and set up fermentations, especially in the sap-wood, increasing their number, though their further growth may be eventually checked by seasoning; the wood, however, shows the effect in proportion to the extent of the fermentations.

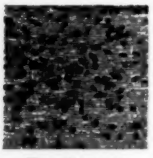

FIG. 23, $\frac{100}{1}$.

The molds play an important part, and are often associated in the decomposition of the sap or fluids in the sap-wood, extending to those of the heart-wood.

The cellulose which composes the principal part of the cell-walls of the various tissues in the wood is of itself quite indestructible, and requires some inducing cause to start its decomposition through the contained sap or moisture, which the fungi can do when warmth and air, the latter in limited quantity, are present for them to grow.

One important aid in the preservation of timber will be, for those whose duty it is to care for it, to acquire more practical knowledge of the fungi which grow on it, and this is not a difficult task. What is needed is to call the attention of the men to the conditions and to the prevention of the growth of fungi. The literature about it is meager, only foreign text-books having been published which describe the general species. Professor Charles H. Peck, in the reports of the New York State Museum of Natural History, from the twenty-third to the thirty-eighth, inclusive, has described a great many species of fungi, and has made the most important American publications to date. For practical use he has done a valuable work in the collection and mounting, in the State Herbarium, at Albany, of over twenty six hundred species, where one can in a short time learn to identify the ordinary species found upon ties and timber. In the Columbia College Herbarium there is a collection of nearly three thousand species of the general fungi of this vicinity, which is also open for study. The facilities for taking up the practical work are abundant. Every railway company has men of sufficient aptitude to learn to identify species and study their conditions of growth, and form from, the materials which can be found upon every mile of their lines, collections of decayed wood, from which the employés can gain knowledge to be put into daily practice to check much of the unnecessary decay of all their wood-work of ties, bridges, cars, and buildings.

The cheapest operation to protect our woods, and quite sufficient for many purposes, is to season or thoroughly dry the timber, reducing the contained moisture from eight to twelve per cent of the weight of the wood; and when in this condition, with a circulation of air around it, to prevent the collection and absorption of moisture, the wood will last indefinitely, as the fungi can not grow in such surroundings. Every one is more or less familiar with the soundness of timber in the upper parts of buildings, while in lower parts near the foundations it is often decayed on account of moisture.

In many situations, however, where timber must be used, the conditions of growth of the fungi are present, and it will decay; some species can be used which resist the attacks of the fungi for a long period, but the final result is decay unless the wood is treated by some process preventing the growth of the fungi, which must be capable of doing either one of two things: 1. It must keep the fibers dry, preventing the absorption of moisture. 2. If the wood must be in a damp place and kept moist, some antiseptic must be present, sufficient to prevent the growth of any of the various kinds of destructive fungi. Timber entirely submerged does not come under these considerations. To use the first process successfully means more than a thin coat of paint or tar on seasoned wood when exposed to continued moisture. It must be some substance which penetrates the tissues of the wood sufficiently far, in case the exterior surface is broken, to prevent any

absorption of moisture. Woods impregnated with the heavy tar or lighter oils are protected more from the fact of prevention of access of dampness to the fibers than by the contained antiseptics, unless in the exception of a great percentage of creosote. In the second method the moisture is permitted to come in contact with the fibers of the wood, and reliance depends upon the antiseptic. In this case, the entire wood should be saturated to give the greatest measure of success, not merely an exterior protection of a half-inch or so in depth, the latter fact, as before explained, being the cause of many of the failures which have taken place. The antiseptic treatment, to succeed, must destroy all the germs which have found lodgment in the timber, and also those which may come from the exterior.

In a general paper I can only indicate the antiseptics which have been fairly successful, though in many cases the failures were due not so much to the antiseptic used as to the faulty manner of application, which can be understood from what has been written.

The four antiseptics which are most used now are chloride of zinc, creosote, corrosive sublimate, and sulphate of copper; sulphate of iron and pyrolignite of iron may be mentioned. The treatment of the wood by bichloride of mercury (corrosive sublimate) was called kyanizing; by chloride of zinc, Burnettizing; by creosote, creosoting or the Bethel process; by sulphate of copper, Boucherie's process. Sulphate of copper has been used for over a century in preserving timber, and when well applied the results have been good. The idea of Boucherie was to force the antiseptic through all the wood-cells, which was correct, and the method successful in proportion to the extent it was accomplished.

The attempts to impregnate wood are made now with nearly all of the antiseptics, in large cylinders capable of sustaining from two hundred to three hundred pounds pressure per square inch, one end of which can be opened and closed for admission and withdrawal of the timber. When the cylinders are filled with the timber they are closed, then steam or heat is applied to vaporize the sap or moisture; after this a partial vacuum is produced and sustained for from six to twelve hours, then the moisture is withdrawn from the cylinders, and the antiseptic is pumped in and raised to a pressure of from one hundred and twenty to one hundred and fifty pounds, which is maintained for from six to twenty-four hours. Porous woods are impregnated quite readily, while the heart-wood of the yellow pine (see Fig. 1) and the white oak (Fig. 3 in August number) are not penetrated so easily, and take longer time. The external pressure may be one hundred and fifty pounds per square inch; yet the hydrostatic pressure in the cavities of the cells, not $\frac{1}{10000}$ of an inch in area, is quite small, the impregnation being to a great extent by capillary attraction and absorption through the cell-walls.

It is evident from preceding statements and illustrations that un-

treated railway-ties in the road-bed are of necessity in about as favorable conditions for the growth of the fungi as could be selected, and consequent decay is not only probable but certain and rapid. Ties of the most durable woods, as a rule, only resist decay for from eight to ten years, while inferior qualities only last from four to seven years.

The consumption of ties by our railway system will closely approximate eighty million the present year for repairs, and, as these require to be cut from special trees from thirty to sixty years old, ten to sixteen inches in diameter, will take many trees which, in as many more years, would yield from six to eight times as much timber. This rapid reduction of the prospective timber-supply is one of the serious phases of the question, and is causing grave apprehension as to the future sources of ties, not only to the railway officials, but to all persons who look to the general welfare of the country. Transportation now is so intimately connected with every business, and its cost so much a part of the price of nearly all articles, and especially of food-supplies, that the increasing cost of ties becomes a subject of national importance. The American Forestry Congress is urging the planting of trees and the better care of existing forests. While the measures it urges may help the supply of timber twenty-five or thirty years hence, they can not meet the exigencies of the case in the mean time. Railway-ties only last from one fourth to one tenth of the time required to grow them, and the forests are now being rapidly cut to furnish the supply. Very few of the railway companies are in a position to grow their ties; but, as consumers of such vast quantities of timber annually, they can take more effective measures to stop the growth of the fungi and check the enormous wastes of timber now taking place.

One important step, when storing ties and timber before using, would be to put down blocks or timbers for each end of the piles to rest upon, leaving an air-space underneath, and pile the ties an inch apart. This would permit a circulation of air and prevent the growth of mycelia, which is so frequent on the first, second, and third layers, when placed directly upon the ground. When this is not done, the fungi grow as much in the ties, in two or three months in the summer, as they would in one or two years in the road-bed.

There is one phase of decay in ties which has been generally overlooked; in fact, it would not be noticed except by making special examinations. A slight fermentation, which would only soften or make the fiber brittle under a rail or around a spike, becomes of greater importance in ties than in beams which have a large factor of safety. Ties of many species of wood, when sound, will cut under the rails to some extent, and the rate will be much increased, in case the fibers are softened or weakened by fermentations; this I found to be the fact in several hundred chestnut, oak, and yellow-pine ties which had been removed from the track, on account of abrasion under the rails, and of mechanical injury by repeated spiking. Either side of the rails

the ties were sound, and would not be called decayed. In the yellow pine the spikes check and separate the annular rings, which permits the entrance and growth of the mycelium of its special fungus, and this weakens the fiber and loosens the spike. In white oak and chestnut the layers separate by breaking through the small tracheids surrounding the ducts (see Fig. 3, August number), those of the chestnut more rapidly. The fermentations are retarded in these woods by the tannin in the cells, but they take place eventually, softening and injuring the fibers around the spikes and under the rails.

In ties which are well treated, so as to preserve them, the fermentations are held in check, and the softening of the fibers is prevented, and their durability and consequent wearing capacity are increased. This is an advantage so important that its full benefits can not be appreciated until actual comparisons are made between treated and untreated ties under similar conditions of service. I have parts of treated ties of over thirty years' service under heavy traffic, trebling their ordinary life, while there are numerous instances in which the oak has doubled its life, and the hemlock has given from five to six times its usual service.

The durability of well-treated ties is well established in this country by considerable experience on various railways. In England, France, and Germany the experience is ample, the ties lasting there longer than we can expect them to last here, from the fact that chairs are generally used to hold the rail and distribute the weight to a greater area of wood than is the case with the base of our rails; and, besides, the tonnage per car-wheel is less than ours. It is our freight-cars, with limited spring action, which cause a large portion of the abrasion of the ties. The economy would be great that would result to the railways by prolonging the life of their ties by treatment; this fact was realized long since, but in putting it into practice the information and experience were not sufficient to enable their engineers to secure the anticipated beneficial results. In fact, much of the treatment hastened the decay of the ties and timber, or, when overdone, destroyed their strength. This need be the case no longer, for the study of many of these failures has given much of the information needed, and the experience in treating wood is now extensive. The cheaper grades, such as the beeches, maples, birches, elms, and hemlocks, having a structure sufficient to sustain a heavy traffic, can be treated and substituted at less expense than the first cost of untreated white oak or yellow pine, and have a greater durability. This would effect an immediate economy in the renewal of ties.

It would be decided economy to treat the higher-priced ties, so as to double their durability. A general example is given of a mile of track on a trunk line, where 2,800 ties are used per mile: This year the ties cost fifty-five cents apiece; to lay them in the track costs fifteen cents more, and their average life will be seven years. To treat these ties

would add twenty cents to the above cost, and give them an average durability of fourteen years.

Twenty-eight hundred ties at seventy cents = $1,960, which would be the cost for seven years, and, for fourteen years, twice this = $3,920. Twenty-eight hundred ties at ninety cents = $2,520, and these would last fourteen years.

The difference in first cost is $560, and the simple interest on this at five per cent for fourteen years is $392, and this added to the $2,520 makes $2,912, a difference of $1,068 for the treated ties per mile for fourteen years. Local conditions would vary the results, but not the principle.

In the present extensive use of timber and lumber, only the roughest approximate estimate is possible of the annual loss by fungi; and the amount of loss can be indicated in only a few items. The cost of replacing decayed ties by the railways of the United States for 1885 exceeded $30,000,000. Repairs of station-buildings and road-crossings, $19,500,000. Repairs of wooden and wood parts of bridges, $6,250,000 (estimated). Repairs of freight-cars, $22,500,000 (estimated). Repairs of passenger-cars, $7,500,000 (estimated). The renewal of telegraph poles and fixtures on 160,000 miles of line constitutes a large item. The loss to the agricultural interests is much greater. The tenth census reports the cost of fencing in 1879 at $77,763,473, the most of which was for repairs. The loss caused by fungi on the 9,000,000 dwellings, with their accompanying buildings, and the $406,520,055 worth of agricultural implements which appear in the census reports, and that on the 6,654,997 tons of marine, and on wharves above water, form other large items. The lumber interests are also a great loser through the quantities of timber that are destroyed in store. The mere mention of these facts makes it evident that the regular annual loss from this source must be rated at many million dollars.

IN THE LION COUNTRY.

By PARKER GILLMORE.

THE majority of people have possessed pets of some description or other, but few are able to say that they have owned a couple of tame lions, for tame they were when I owned Leo and Juno, and I can vouch that more interesting pets were never the property of any individual. How I became their possessor I will endeavor to the best of my ability to inform my readers.

In those happy days, now some years past, when war had not broken out between the Boers of the Transvaal and Great Britain, I was hunting large game to the north of the Crocodile River, where the country of Lubengulo, King of the Matebeles, abuts on that of Kama, King of

Bamangwatos. The margin of the Crocodile River here is covered with thick timber or dense masses of reeds, but, as you retire a mile from the above-named water-course, bush-veldt becomes the dominant feature of the landscape, and is the haunt of innumerable species of the larger descriptions of African antelope. This may well be accepted when I state that from my wagon-box I have seen, at break of day, hartebeeste, wildebeeste, eland, and sassabi within easy rifle range of my position. Moreover, buffalo, quagga (the favorite food of lions), and giraffe were far from scarce in this vicinity. Thus it is not to be wondered at that the king of beasts should be found numerous where there was to be obtained such an abundance of his favorite food, while water and shelter, two necessaries to his existence, were ever close at hand.

Nightly we had heard for nearly a month the deep-muttered growl or awful roar of the monarch of the waste, but, the weather being fine and the nights clear, had little dread of his attacking either my bullocks or horses. Another protection I possessed against lions intruding themselves into my camp was, that with me were a troop of dogs of such excellence as had seldom been seen in an African hunter's camp. Several of these dogs had been imported, and great care was taken in their selection that strength and courage was their *sine qua non*, as they were to be my companions in a very distant journey.

The other dogs that completed the pack had been procured from the colony, and therefore had considerable experience in the pursuit of the smaller varieties of buck, as well as an occasional encounter with some of the larger members of the cat family, such as leopards, caracals, etc., for these species of the *ferœ naturœ* still are to be found in considerable abundance south of the Orange River. The morning previous to the occurrence of the incident to which I owe the obtaining of my two pets, Leo and Juno, broke with such an appearance of bad weather that, by the advice of my servants, I determined to shift my camping-place to more elevated and, therefore, drier ground. A ridge, thickly covered with *mapini* brush, and here and there studded with meruli and mimosa trees, was selected for our new encampment, and, as the distance to it was not over six miles, it was not deemed necessary to inspan the bullocks till three hours after noon. Although the weather had threatened since sunrise, the rain kept off until we had completed about half our journey, when, as is not unusual in tropical climates, commenced one of those down-pours that have to be experienced to be appreciated. But this was not all ; with the rain came thunder, and with the thunder, lightning, of which it would be difficult to say whether the awe-inspiring voice of the one was more terrible to listen to than the sight of the brilliant, rapidly repeated flashes of the other. Bullocks can not *trek* with wet yokes, or their shoulders become galled ; thus I had to call a halt, although no shelter was near to shield us from the warring elements. I have witnessed thunder-storms in the

Rocky Mountains, West Indies, and Malay Archipelago, but never have I witnessed them so terrific as in the interior of South Africa; certain am I that in no other part of the world are they so dangerous. And the whole animal creation seems to be well aware of this; for whether it be the Caffre or the ox, the elephant or the giraffe, all equally appear to dread the tempest's violence, and become for the time being so prostrated with fear as to remain awe-stricken on the spot where they have been overtaken, without one thought of seeking shelter. Having upward of a couple of hundred-weight of gunpowder in my wagon, to have it struck by the electric fluid would have been certain destruction to all my belongings, so I took the only precaution in my power, viz., to unfasten the chain, *trek-tow*, from the dissel-boom, so that that important portion of my gear should not act as a conductor to the inflammable part of my load. In proportion to the violence of these hurricanes, so short is their duration; thus in an hour the storm had passed to leeward, and naught remained to indicate its visit, save an occasional distant flash of lightning and the muttered deep intonation of the retreating thunder. Soon the cattle were again made fast to the wagon, and with hurried steps we pursued the remainder of our journey. No doubt we rejoiced that the storm had passed; but, if I and my Caffres did so, every creature imbued with life appeared to do likewise. Thus the francolins and korans, which had formerly been silent, now piped and chattered from every ant-heap; while the gorgeous bee-eaters, sugar-birds, brilliant orioles and sociable grossbeaks disported themselves in every direction. Even the grasshoppers and lizards had found a voice, and with it seemed to thank the Creator of the Universe that the danger had now passed. Of course, after the rain the *trek* was heavy, but fat and young bullocks, with a light load behind them, soon traversed the intermediate space to our new camping-ground.

In a well-organized hunting expedition every member of it has his allotted task to perform; thus some are employed in cutting thorn-bushes to make the cattle-kraal, while others gather fuel for the night-fires, or assist the cook in preparing the evening meal. Where we had halted timber was not abundant, and what we obtained there was so saturated with the late rain that it was not without considerable difficulty a fire could be made from it. As the sky had become clear and bright, master as well as man anticipated a dry night; but, as the sun went down, dark opaque clouds commenced rising to the eastward, which gradually shut up the face of the heavens, causing the surroundings to be involved in inky darkness. The wind now began to rise in oft-repeated fitful gusts, driving with it sheets of penetrating rain that made even the interior of my wagon far from comfortable. It might have been eight o'clock or thereabout when my Bechuana hunter reported to me that the bullocks were exceedingly uneasy in their kraal, adding further, "Baas! there are lions about, and, as the

fence round them is not strong, I think you had better tie the bullocks up to their yokes." Advice from such a source was not to be disregarded, for this man had spent all his life among the wild beasts of interior Africa, and knew their habits and haunts as well as we do those of any of our domestic animals. Thus, after much trouble, and with the assistance of my lanterns, the bullocks were removed from the kraal and made fast to their respective yokes, while the end of the *trek-tow* farthest from the wagon was firmly secured to a tree by the aid of a green *rheim*, the brake on the after-wheels being firmly jammed down. Having taken these precautions, William bade me good-night and turned in among his companions under my desert house. The poet says, "Coming events cast their shadows before." Some feeling of this kind must have actuated me, for I had an intuitive perception that, before daybreak made its appearance, some misfortune or other would occur. Again and again I filled my pipe, and almost as often took my rifles from their rack, to assure myself that their breeches were not under the drip that came from many a rent in the tilt. I tried to read, but, although I had that wonderfully entertaining work, "The Woman in White," I could not concentrate my mind upon it.

Twice I had gone forth and added fuel to the far from brilliant watch-fires, and while doing so did not fail to observe that none of the bullocks had lain down, but with anxious, distended eyes gazed earnestly up to windward. *Trek* oxen are, without exception, obtsinate, perverse creatures, sometimes taking alarm where nothing is to be dreaded, at other times not taking the slightest precaution to avoid danger where it must have been obvious to them. So, seeing nothing, hearing nothing, I retook myself to my shelter. I had about finished another pipe, when a sudden prolonged pull upon the *trek-tow* so violently shook my domicile that, if proper precautions had not been taken, it doubtless would have been overturned. At this moment my Bechuana boy placed his head under the curtain of the tilt, and in smothered words told me that he knew there were lions round us. Not doubting the truth of his statement, I professed to disbelieve it, for, said I, "Why don't the dogs challenge them? Where are the lazy curs?"

William—for that was my boy's name—promptly answered: "If one or two lions here, dogs bark; but I think that there are seven or eight, and that they are scattered round about us, so that dogs are afraid to go into the bush." Scarcely had my boy done speaking when I thought that the wagon must really go over, for the horses that were tied to the sheltered side of it commenced to pull and jerk their halters with such violence as several times to raise the weather-wheels an inch or two off the ground. As nothing so reassures these animals, when alarmed, as the human voice, I got out of my domicile and stood at their heads and talked to them in such kindly language

as they were conversant with; in the mean time ordering all my attendants from under the wagon, directing them at the same time to pile on more fuel so as to make a blaze as soon as possible.

Dark as the night was, all were busy around the little encampment, if I except the dogs, who seemed to be possessed of such timidity that neither words nor blows could drive them out from the shelter they had taken between the wheels. For some minutes all had become quiet, and I commenced to hope that it had been a false alarm, when a roar so loud and close as to awake the echoes of the surrounding koppies broke the monotonous stillness of the night. Such a roar I have never heard previously or since; let him that likes say what he may, it made the earth tremble. To the reader it may appear impossible that any animal can produce a volume of sound that almost rivals the thunder in its density; but let me assure him, if he has heard a mature male lion, in the full vigor of his life, give utterance to his wrath, he will agree with me that there are a sublimity and grandeur in the voice, which, if they do not equal the depth and power of thunder, very nearly approaches to it.

If quiet had comparatively reigned before, now all was excitement. To and fro the bullocks rushed, trying to break their *rheims*, the horses reared and pulled upon their halters as if determined to strangle themselves, or upset the wagon, while every native who was not armed seized a fire-brand and shouted and called to my animals to endeavor to still their fears. So intense was the darkness that nothing could be seen, yet William fired a couple of shots in the direction from which he imagined the sound proceeded. The blaze and report of his heavy elephant gun, one would imagine, would have driven off anything in the form of a quadruped; but not so: the lion roared again at even shorter distance than at first, causing the bullocks to become frantic with fear, and therefore to use their utmost power and strength to break loose.

I thought I could trust my *rheims*, but alas! I was in error, for one more violent struggle than had previously been made took place, and they gave way, and the whole team went down to leeward as if they were stampeding before a forest fire. As the method (for it certainly is a preconcerted and arranged plan) adopted by lions when about to attack a span of cattle may not be known generally, I will briefly attempt to describe it. Lions, as a rule, hunt in family parties. A very old male, not unfrequently incapacitated from taking an active part in pursuing game, is generally to be found at the head of this *coterie*, and on him devolves no unimportant part of the programme adopted by them when a trader's or traveler's cattle are resolved upon as the victims of their ferocity and power.

Down to leeward, a hundred or more paces below where the bullocks are made fast, the young, active males and lionesses place themselves behind what available cover is to be found. This being done,

the aged manikin goes to windward of the encampment and shakes out his abundant mane in the breeze, so that the effluvia from it may be carried down to the excited draught animals. One sniff of the tainted breeze in a moment brings every ox to its feet; when standing, often trembling with fear, they gaze with dilated eyes into the impenetrable darkness. Closer and closer approaches the aged lion to his victims, shaking and reshaking the tawny dense covering of his fore-quarters; then, if the traveler's *rheims* be not strong, he may look out for a stampede; but should they hold, the aggressor, as a climax to his former manœuvre, gives utterance to his deepest and loudest roar, when the frightened beasts, if not secured by the stoutest fastenings that can be obtained, will break off and rush with inconceivable rapidity into the very jaws of their foes secreted to leeward.

Such was the plan adopted on the occasion of which I speak, and the result was the loss of three of my best *trek* bullocks. However, I had one satisfaction: as the patriarch followed on their heels, assisted by the light from our now blazing fires, I was enabled to place a pair of ten-to-the-pound bullets through his tawny hide. This I was certain of, for I heard distinctly the thud, that never to-be-forgotten and tell-tale sound of success that quickly responded to the delivery of each shot. My performance in marksmanship was not wonderful, for the object I fired upon was large, and within fifteen paces of where I stood. The foe nevertheless did not drop in his tracks, but continued his course, evidently intending to join his relatives and participate in the now provided banquet of newly slaughtered beef. But man proposes, God disposes, for many an ominous growl of pain distinctly told that the old marauder was not in a frame of mind or body to enjoy the feast. The night was so intensely dark that it would have been utter madness to have risked my life or any of my people's to drive the lions from their prey, so we satisfied ourselves by piling on fresh fuel and firing an occasional shot in the direction in which we knew the feast was taking place.

With the break of day the troop had departed, leaving behind them nothing but a quantity of scattered bones, half a dozen hyenas, and as many jackals to tell of the tragedy which had occurred but a few hours before. Soon the unclean brutes followed the example of their betters and skulked off in various directions, doubtless with the intention of returning when the camp was deserted, or as soon as night again placed her impenetrable seal of obscurity upon the landscape.

On inspecting the locality where the disaster had taken place, an indentation in the ground was discovered, where several pools of coagulated blood were found, the soil around them scratched up and tufts of grass torn by their roots from the ground scattered about, while the only spoor in the immediate vicinity was that unquestionably of the old warrior on whom I had opened fire. William took up his trail, and, at the distance of half a mile, our foe was detected under

the shelter of a mapini-bush. Poor brute, it was evident that he was sick unto death ; still, his heart was willing for the fight, though his body was weak in power to assist him. On perceiving our advance, with a determined effort, he gained his legs and faced us, his countenance as plainly as language spoken showing that surrender without a final effort was not intended.

I fear I was prompted by too many feelings of revenge to appreciate the noble sight the discomfited foe presented ; for what wonder? Had I not lost three of my best draught-cattle?—a loss the magnitude of which can scarcely be understood except by those who have been placed in similar positions. The gallant beast's head was down, his lips curled upward, so as to show his formidable tusks, while his tail, as stiff and straight as a crow-bar, was erected aloft. If he had possessed the power now, he would have charged ; as it was, he remained as splendid a target as the most fastidious could desire. I aimed between his eyes, and, ere the smoke had drifted away from the muzzle of my smooth-bore, the hero lay extended at length upon the sparsely covered veldt. While admiring my prize, three Makalakas approached me ; the grin upon their countenances showed that they had something unusual to tell, or else something to dispose of. I was not long detained in doubt which it was ; for from under a kaross two of their number produced each a lion cub, about the size of a six-months-old kitten. While admiring the little beauties, who seemed in no way to feel the awkwardness of the position, a roar was heard in the distance, which caused the Makalakas to pick up their treasures and rapidly gain a position behind William and myself. "By gum," exclaimed William, "here comes ma!" and scarcely had he delivered his brief assertion than her ladyship made her appearance, trotting hastily toward us. When seventy or eighty yards off, she halted and uttered a suppressed growl, different in intonation from any that I had ever heard emanate from any of her family. Up to this time the little wee beasties had been models of propriety, but the voice of their dam had in a moment transformed them into fiends incarnate, for they scratched and bit their possessors with such determination and energy, at the same time squealing, that the Makalakas were fain to drop them on the ground, the better to enable them to retain possession of them. The three natives had a busy time of it in accomplishing their purpose, but William and I had other and more important matters to attend to, for, the moment the lioness heard the screams of her offspring, open mouthed and almost flying with velocity she charged upon us.

My first shot staggered her and brought her to the ground, but in an instant she regained her feet, and, nothing daunted by the check she had received, continued her headlong course. Again I pulled the trigger, and down she fell, her shoulder smashed, for her left fore-leg dangled and doubled under her as if deprived of joints ; but a three-

legged lioness is not incapable of doing mischief, and so William thought, for at only a few paces he administered the *coup de grace*, aimed in the region of the ear, which put a favorable termination to a short but very exciting scene.

My new acquaintances, I learned, were herdsmen of Lubengulo, King of the Matebeles, who, when driving their cattle up, to kraal them for the night, disturbed a lioness; a Bushman who was with them fired at her a poisoned arrrow, which, it was believed, had taken effect. As a scratch from one of these pygmy weapons is almost certain to produce death in a few hours, my new friends had gone at break of day to search for their anticipated prey, but, losing the trail and making sundry efforts to regain it, they unexpectedly discovered the youngsters in a hole scooped in the bank of a dry water-course, which they at once secured.

Fortunately, they encountered us when they did, or *Madame la Mère* would have made them regret their temerity. On examining the lioness, no indication that she had been struck by the arrow of the Bushman was to be seen; either the bowman had missed her or this was not the animal he had shot at. A couple of pounds of gunpowder and four bars of lead were treasures too valuable for natives to refuse, so Leo and Juno became my property. The herdsmen, not satisfied with the discovery that the killed lioness was not wounded with the Bushman's arrow, renewed their search, and in the course of the day, on their return to their kraals, passed my encampment bearing a newly taken hide, satisfactory evidence of the rapid and fearful certainty of the virus with which they anoint the points of their diminutive weapons.

There are several poisons in use among the aboriginal tribes of Southern Africa, but that extracted from a caterpillar, and designated by the natives "mangue," is the most fatal. The pain which the victims suffer who have been inoculated with it must be fearful indeed; but it is not long endured, for two or three hours generally put an end to the stricken animal's existence. Of course, this time is more or less protracted by the size of the wound, the locality in which it is situated, and the quantity of the venom used; for instance, on one of the tributaries of the Zambesi, a lioness that had been wounded at sundown did not expire till the following daybreak, during all which time the cries of anguish that she kept repeating, terribly told how fearfully the poor creature was suffering. On examination, this victim of the poisoned arrow only had a slight puncture beneath the skin close to the flank, but the firmness of the hide had prevented the missile from falling from the wound.

As the habits of semi-barbarous people always possess great interest for me, I trust they do so for my readers, and I will therefore describe the two other poisons in use among the Bush-people, and the manner in which they are employed to serve their purpose. First, I will ad-

vert to the juice of the euphorbia. This is a family of plants all alike foreign to the European eye in appearance, although not by any means strictly tropical. Some species possess much more poisonous matter than others, the most deadly being in appearance like a crooked pole with a bunch of long, hard leaves decorating its summit. When employed by the natives for the purpose above spoken of, it is collected in quantities on the margin of a small vley or pond of water, when it is beaten between stones till the necessary quantity of the juice impregnates the water. At night unconscious game, probably thirsting from the hours they have passed in the sun-dried desert, come to the vley to satisfy their craving for drink, but scarcely have they done so when they become intoxicated, and soon after lie down to sleep the sleep that knows no waking. In this death I do not think the victims suffer much pain, for all that I have seen that have been killed in this manner were in the positions they would assume if they had laid down to take their natural sleep.

It is strange that this poison is much more injurious to horses, zebras, and quaggas, than it is to cloven-hoofed or horned animals. Why I state this is that while the former will not proceed over half a mile after they have imbibed the subtile fluid before being incapacitated from going farther, the latter will travel many miles ere they drop, if drop they do, for I am convinced that many escape death from this poison, although possibly brought very close to it.

To carnivorous animals, such as lions, leopards, hyenas, dogs, etc., it does not produce death, only stupefies them for the time being; at least, such was my observation in reference to my dogs, when I knew that they had drunk a quantity of the diluted water. It is to be regretted that the natives should use such a means to secure game, for I know of a whole herd, amounting to over fifty zebras, perishing in one night, although the requirements of the few inhabitants of the district would have been amply supplied by a couple of carcasses, for it must be remembered that in these regions decomposition sets in very rapidly after life becomes extinct.

The third poison used by these most interesting natives, the Bushmen, is that taken from the glands of the Mamba cobra, or puff-adder, with which the points of their arrows are thickly coated. Exposure appears to weaken these reptiles' virus, for, previous to any important hunt taking place, the barbs of the tiny weapons receive a fresh dressing of the baneful fluid. Game killed by all the above methods is eaten by the human family, or carnivora, without producing any evil effects.—*Land and Water.*

SOME OUTLINES FROM THE HISTORY OF EDUCATION.

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I.

IT is noticeable that, upon the subjects of education and religion, almost every one believes he has something to say. It is noticeable also that this belief is often quite apart from knowledge or special preparation. In mathematics, we wait for the judgment of the mathematician, in chemistry, for the judgment of the chemist, while in education we wait for no one, but bring forth our opinions loudly and dogmatically. We have, as a pleasant consequence, the fact that the nonsense written and spoken about education is like no other nonsense for completeness, except that written and spoken concerning religion. What fledgling does not think it in his power to produce a helpful tractate about God, his nature and *modus operandi?* In like manner, who can not write a *scientific* tractate upon education?

It is a consideration of much moment, when approaching such a subject as education, to reflect that true science ends controversy. The Ptolemaic and Copernican systems may not share the heavens between them. Is it said we have various systems of theology? This is painfully true, the reason being that we have not a scientifically adequate one on the face of the earth. The same is the case with systems of government and political economy. We may safely conclude that the fact of the existence of diverse systems is proof that the given subject has not been reduced to scientific expression.

From earliest times there have been teachers and students; from earliest times great-minded men have given themselves to the work of education. We see throughout Europe ancient seats of learning cared for by governments and reverently regarded. More than this, during the past two, even three centuries, enthusiastic efforts have been made to found education upon its true bases. Most fitting opportunities were granted to men who thought they had the science of the matter; experiment after experiment was tried; and yet to-day we find ourselves in the very thick of the conflict, on the threshold of great changes, and apparently no nearer the education-science. Naturally the question arises, Why is this so? as naturally also the further question, What have we to expect? These inquiries are vitally related, and the answer to the second follows from the answer to the first.

Past endeavors have not given us a science of education because, from the nature of the case, education is the last subject that can become a science. Who is it whom we seek to educate? Man. What

is man? Evidently if we are to educate man upon scientific methods we must know what man is; we must know the laws of his being, the relation of these laws to one another, and to the end for which man is made. The science of education, therefore, presupposes a true psychology, and a knowledge of the formation of character based upon this psychology. In our country so-called educational treatises are written by persons who have neither psychology nor minds to comprehend it; and, while these works may have much valuable practical matter, they should not be received as in any sense scientific. With one exception ("Education," by Herbert Spencer), the only works which may claim to pretend to treat education scientifically are German, and every one of these bases itself directly upon some psychological system. I need but name in illustration A. H. Niemeyer's "Ground Principles of Education," Fred. Schwarz's "Instruction-Book of Pädagogik," as coming directly out of the Kantian thought, or Miss Anna C. Brackett's translation of "The Philosophy of Education," by Professor Rosenkranz, the biographer of Hegel, as an application of Hegelian thought to education. We of to-day are feeling the influence of an entirely different philosophical system from either of those above mentioned. Our educational methods are being remarkably and rapidly modified. This change has received its psychological expression in England, and Mr. Spencer may be regarded as the representative thinker of this new school. Here the idea of man as to his nature and the laws of his development is distinct and peculiar; it gives us an education based almost entirely upon instruction in the physical sciences.

Pending the attainment of a psychology that shall secure sufficient general recognition to become the source of proper reform in our educational efforts, it would seem that nothing could be more profitable than some consideration of the history of education. It is surely matter for regret that a subject so important as this should not long since have been examined in the light of the idea of development. It is our good fortune in most other matters to have abandoned *a priori* discussion. Even with so deep a work as Goethe's "Faust" we feel that it is necessary to proceed historically if we are to gain correct ideas as to its origin and meaning. We have come to recognize this "Faust" as the life-poem of one of the greatest of our race; we have come also to know that the material which Goethe transformed was deeply rooted in our common humanity, and had already passed through a natural and vigorous development long before the poet's day. How much profundity of nonsense this historical feeling would have saved us in literature and religion can not be estimated. Our debt to Comte as the living source of modern historical feeling may well temper our judgments before his later speculations. We have a right to expect that whatever value there is in general historical study, as related to the life and works of men, we should find in the history of education

as related to the practical matter of teaching and learning. There is even a closer relation between general history and the history of education. This is seen in a moment if we consider again who is to receive the education. The ideas which man has entertained about himself have determined alike his history and his education. The profitable thing in considering our subject historically is exactly this detection of man's ideas of himself. We see these ideas shaped by varying circumstances, and in turn shaping man's activity in every direction. Education has had a wonderful unfolding and there is not a phase of its course which may not be traced to that idea of man's nature and destiny which prevailed at the time.

This close relation between general history and the history of education has led to the adoption of the same broad time-divisions in both subjects, as follows :

Before Christ.

From Christ to the Reformation.

From the Reformation to Pestalozzi.

From Pestalozzi to the present.

This division is the one chosen by all authorities in the history of education, though special reference may here be made to Schmidt's "Geschichte der Pädagogik," a work of remarkable philosophic value, and one to which I am greatly indebted in the preparation of these articles.

Turning to the first division, we find that the nations having a history and corresponding systems of education are the Chinese, the Indians, the Persians, the Egyptians, the Hebrews, the Greeks, and the Romans. Nothing can be more interesting and profitable than to observe how directly and completely the education found among these peoples was shaped by the ideas which they respectively entertained about their own nature and destiny.

We have frequently been asked to consider the peculiar appearance which China presents in history. There is something here as sad as it is peculiar. Centuries before the nations of to-day had emerged from barbarism, China showed remarkable advancement in civilization. We should not think here chiefly of the public works constructed by this people, such as the wall of defense or the canal, or even of their knowledge in special directions, such as the use of gunpowder or the art of multiplying impressions from woodcuts, or the use of porcelain, the compass, and the bell. The fact above all others to be noted is, that in no country, without exception, has such direct and supreme value been placed upon education as in China. The educated man alone could hold office in this vast empire ; riches and birth were of no avail if the man were uneducated. We may contrast this profitably, so far as the idea is concerned, with our American suffrage system, where the vote of bestial ignorance counts for more than that of trained intelligence, and where *the* qualification for office is availa-

bility. In China, the higher the office to be filled, the higher must be the education. Such being the estimate placed upon education by this people, we should not judge that stagnation would prevail in China for over twenty-five hundred years and education become nothing but pitiable mummery. We learn a valuable lesson here as to the way in which one fundamental error can vitiate centuries of national existence. China, as arrested development, has been aptly compared to the feet of her women.

In seeking the cause for such arrest of growth, we come upon the idea which this people entertained of themselves: they were members of a family—nothing more; the emperor was their father. This family-idea, applied everywhere and never transcended, kept the people children. With our modern feeling of individuality so fiercely coursing in our veins, we find it almost impossible to realize that in China there were no *persons*, no individuals. A human being fully grown, and with what should have been the strength of manhood upon him, was simply a son, a child. He did not belong to himself or to a nation, but to a family. Absolute obedience to father and teacher prevented all progress beyond the condition of father and teacher: learning was ceaseless repetition. The Chinese had village schools, town schools, and universities; their highest reverence was for the most learned, and their education found its supreme test in an act of memory.

Passing from China to India, we find that man's idea of himself is somewhat enlarged. The people are divided into four castes: Brahmans, warriors, merchants, Sutras. Birth determines each man's condition and duties; to be a Brahman is to live and die a Brahman, to be born a Sutra is to live and die a Sutra. No physical law is more inflexible than the law of caste in this far-off land. But these social divisions show improvement over the condition in China. Man is nearer himself as member of a caste than as member of an enormous family. Further, man in India has been shaped by a most wonderful religion. The special mental characteristic of the Indian, imagination, fancy, was constantly and powerfully influenced by the outside world. Nature seemed to have produced one impression above all others upon the Indian mind, the impression of universal necessity. We find these elements at work determining the idea which man had of himself and molding the education of India. The Sutras were so low as to be beneath all education; the other classes were trained for their special duties—the Brahmans in religion, the rulers and warriors in government and war, the merchants in trading. As there might be members of the higher castes in villages, provision was made for their instruction by elementary schools. This instruction consisted in reading, writing, and reckoning. A teacher, with staff in hand, would take his place under a tree and teach the boys sitting around him. In arithmetic only the rudiments were taught. Writing was

closely connected with reading, and was taught by a stick in the sand; then on palm-leaves with an iron point, and at last on plantain-leaves with a kind of ink. In the higher schools at Benares, the *exoterics* (which might include members of the second and third classes) were taught grammar, prosody, and mathematics; the *esoterics*, poetry, history, philosophy, astronomy, medicine, and law. The pupil is a listener for five years; then he is allowed to take part in the discussions. The period of study lasts from twelve to twenty years, and the highest instruction is furnished by a study of the Vedas. Though the Indians had no theory of education, they expressed wise educational maxims most beautifully by fable and poetry. "War-skill and learning are both renowned, but the first turns to folly in old age, while the second appears worthy for every period of life." "Culture is higher than beauty and concealed treasure, it accompanies you upon your journeys through foreign lands and gives an indestructible power." "As the tree shadows him who would cut it down, and as the moon illumines the huts of the lowest, so should a man love those that hate him." "Be humble, for the tender grass bows itself uninjured to the wind, while mighty trees are rent in pieces by it." "The wise man should strive to attain knowledge as though he were not subject to death, but he should fulfill the duties of religion as though death were settling upon his lips."

Did the special purpose of the present paper allow, it would be instructive at this point to notice the reformation in the religion of India. Brahm and Nirwana as root-ideas appear to have been essentially the same, and the highest glory of man was absorption in the *all*. That which is especially instructive here is the fundamentally different development of this common idea in Brahminism and Buddhism. For the Brahman, God is in everything: everything *is* God; from this come the deification of Nature and all forms of animal-worship.

For the Buddhist, on the contrary, since the highest blessing is the loss of one's self in Nirwana, everything that has independent existence must be cursed by the very fact of existence. We must pity, not worship, anything that *is*. From this interpretation of the common idea, what are wealth and social distinctions? Where *all* is wretched, how can one thing be better than another? Buddha, well called the Luther of India, could cut clean through the caste-distinctions and make a way for what, long afterward and under other influences, so mightily prevailed in Christendom, the conventual system, the order of monks.

Buddhist education was training in Buddhist religion. The principles of this education are found in the catechism of the Buddhists, and take the form of such commandments as these: "Thou shalt not steal. Thou shalt commit no act of impurity. Thou shalt do no wrong by thy speech. Thou shalt drink nothing intoxicating. Thou shalt not kill any living being."

Among the remaining Oriental nations we find ideas respecting man that are equally narrow and ill-adapted for advancement. In Persia the national idea, in Egypt the priestly idea, among the Israelites the patriarchal idea, determined respectively all that was undertaken in the way of training. It is a singularly instructive fact that man, as an individual, first appears among the Greeks and Romans. Here lies the radical difference between the contributions to history offered by the Eastern peoples and that progressive movement commenced at Greece and Rome. The trite saying, "History began with the Greeks," finds its philosophy in the fact that here man entered on his career as an individual, a person. This idea of individuality, however, was by no means unlimited. It never exceeded the boundaries of Greece and Rome. A Grecian was a person, a Roman was a person; for them there were rights and opportunities. They could be educated. Man *as man*, however, was not yet known. Despite this serious limitation we must call the advance shown by these peoples great when compared with all that had preceded. To say I am an individual Grecian, an individual Roman, is far better than to say I am a child among millions of other children, or, I am a member of a caste. It has been frequently observed that education among the Greeks and Romans shaped itself in strict keeping with the root-difference between these peoples. For the Greeks, highest excellence was *beauty*, in body and mind; for the Romans, it was *result*, something brought to pass, whether physical or mental. Therefore the Greeks surpassed in art and philosophy, the Romans in war and law. It has been often remarked that our first theoretical treatment of education is furnished by the Greeks. Plato, in his "Republic" and "Book of the Laws," states the fundamental principles of education, and surrenders the individual to the state. Education is an affair of the state and for the state. Here is the limitation of individuality, a limitation not to be exceeded at this time by this people. The Romans, not demanding public education, left the child to home training for his earlier years, but placed him as a youth with some celebrated jurist for special instruction in law and state-craft. This Roman training was, from beginning to end, *practical*, and never lost such character even after the rhetoric and philosophy of Greece were added to the subject-matter of education.

Human history, and consequently education, were now to feel the impulse of a new movement. Christianity, whether true or false, appears with the announcement that "God hath made of one every nation of men for to dwell on all the face of the earth." In this is contained a truth that gave Christianity power to supplant heathenism and to shape the course of education for centuries. The history of education for a long time after Christ would be a history of the Church. We need concern ourselves with this movement only so far as to find a thread of development that may lead from past times to

the present. Persecution was the inevitable experience of those who allied themselves to the new faith. During the earlier years the struggle for existence was constant and absorbing. The children were necessarily kept at home and taught only the simple forms of the new faith, or were sent to heathen schools for instruction in reading and writing. This practice continued until persecution had relaxed its grasp sufficiently to allow some reflection upon the new religion as a body of belief and teaching. With this reflection came the supposed discovery that Christianity was something purely spiritual and heavenly, having no concern with earthly affairs. The error here, though natural, was fatal. A misunderstood Christianity led men astray and multiplied sorrow for the race. With the growth of this religion it became necessary to instruct the converts in the faith they were about to adopt. During the first century A. D., institutes for the catechumens, or schools for teaching Christianity, were established. The heathen converts were at first grown persons, and were taught nothing but the principles of the new religion; all other training they must receive from the heathen schools. Christianity was to train for heaven, not for earth. The order of the monks appeared in Palestine, Constantinople, and Rome. Education was the special care of these men, who had forsaken all worldly interests, and education consisted wholly in such instruction as would fit for the duties of the order.

With further advance Christianity began to reach out over all departments of life. Now, for the first time, leading men among the Christians demanded that the children should be taken from the heathen schools and receive all their education at the hands of Christians. That the catechetical schools made no break with heathenism is plain. Clement was a leader of these schools at Alexandria from 189 A. D. He was master of classical training, and brought his learning to the service of the new religion. He felt no pronounced opposition to heathenism, but believed it could illustrate and advance Christianity. He says, "Mosaic law and heathen philosophy do not stand in opposition to one another, but are related as parts of one truth; both prepare, but in different ways, for Christianity." The new force, however, was irresistibly working in contrary direction. A few years from the death of Clement the new religion announces its direct and uncompromising hostility to heathenism and all forms of heathen education. There was war to the death against everything connected with Greece and Rome. Education must train for heaven and for nothing else. By imperial order the schools of philosophy were closed, 529 A. D. No more were children to be suckled in a creed outworn, no more could one "have sight of Proteus rising from the sea or hear old Triton blow his wreathed horn." From the fourth to the sixth century heathen culture was trampled out by the march of the barbarians over the empire.

To estimate in any sense justly the course of events through this

formative period, it is, I think, important to recognize the elements at work in the process. The East and the West were to be dealt with by a new religion; more than this, the barbarian must be subdued; the savage conqueror from beyond the Alps must be trained. As has been said, it would prove far more difficult to adjust philosophies and old religions to the new faith than to convert and baptize the rough, fresh peoples who were but just coming to self-consciousness, and whose vigor would furnish material for the world's progress. When we consider the magnitude of the problem, we shall not wonder that the day was long in dawning; we shall not wonder that Christianity went astray from the path whose direction it contained within itself. Throughout the entire middle-age period Christianity was unable to assimilate, organize the heritage of classical thought. It seemed necessary that Christianity should preserve existence and form as against Grecian philosophy and Oriental mysticism by rising above all human things, by fixing the eye on heaven.

At this time, when the treasures of the world's learning seemed lost beyond recovery, the cry is again heard, "*Ex oriente lux!*" One of the most brilliant and astounding phenomena of human history now appeared—Arabian culture.

It has been said, and perhaps too often of late, that what we regard as the deeper differences of our fellows correspond to the broad divisions of the earth. Races and peoples differentiate themselves according to climate and territory. This is taken as a clew to the proper definition of a people—viz., "a totality of individuals in the mass of humanity," a totality conditioned by the land to which they belong and by the stage of development on which they enter. It is important to remark the word *conditioned.* The distinguishing characteristics of a people do not come entirely from without. There is something more than climate and environment. This may properly be called the race-type, which, like the primal constitution of the individual, is never *created* by education; dependent on land and climate for expression, it unfolds after its own kind. The impress of the original type is found wherever the development has been sufficiently advanced to bring out the varied parts of our nature. By this is not meant that each people accomplishes something distinctive in religion and government, morals, science, and art.

Our meaning rather is that the mark of each people is plainly visible on all these manifestations. The statement is just that each people is an *individual* within the race, and that it will show the working of *three* forces—original constitution, climatic condition, influence from adjacent nations.

Our examination of any national movement can not deserve approval unless the idea of development control the investigation. We are above being satisfied by facts alone. History is alive. It is no longer enough to know that at such a time the Arabians conquered

Spain, passed on to France, were defeated by Charles Martel, ruled for centuries in Granada, lived luxuriantly, fostered literature and art, were at last driven back whence they came, and are now as nothing in the world's life. We need to discover the natural place and functions of the Arabian people in history. We must know this people as a *growth* on the common tree. Any detailed examination of the kind indicated is foreign to the purpose of this paper. While, however, nothing but the merest outline can be drawn, it should consist of living lines—i. e., of those features which represent the causes at work in this given historic unfolding. It is well understood that Arabia is physically one of the most peculiar of all countries. It seems preestablished to make tribes, to prevent nationality. Its shape is that of a triangular peninsula, limited on the west by the Red Sea, on the south by the Indian Ocean, on the east by the Persian Gulf, on the north it joins Syria. The most remarkable feature of the country is the almost impassable separation between the exterior and interior, between the coasts and the central land. This separation is made by a broad belt of desert, yet beyond the sand-wastes is the Arabia of the Arabians, the most productive and healthy portion of the entire country.

Not only is the land itself peculiar, it is peculiarly placed. Alexandria lies upon the left, Jerusalem and Damascus in front, Persia and the Orient upon the right. The remark is familiar that almost all the philosophical and religious systems of the known world would meet here in passing. We need a few sentences as to the people themselves and their condition before the appearance of Mohammed. The origin of the Arabians is lost in tradition. There is no question, however, that the division of this people into classes obtained from earliest times. There were the pure Arabs and the Mostarabs; the former lived in cities, the latter were the true sons of the desert and led always the nomadic life. Here we find the origin of the present well-known separation of the people into Ahl-Bedoo, or dwellers in the open land, and Ahl-Hadr, or dwellers in fixed localities. We find the complete expression of the nomadic Arab existence in the clan, the family. While the residents in cities show such modifications as would be expected from closer and more permanent intercourse, still here also the family, the tribe, was matter of chief consideration. Arabian land had severed the Arabian people at the same time it had developed immense physical endurance.

We need some characterization of the Arabian nature, that individual and primary constitution which, produced by no climate or circumstances, developed as external conditions might necessitate, yet always *as itself*. The Arabian nature has been said to have the following characteristics in remarkable degree and intensity: "Seriousness and pride, veracity, generosity, hospitality, passionateness and ardor in love and hatred, vindictiveness running on and on through

years to the last member of the tribe, and often mounting to extreme cruelty. Mentally the peculiarities of the people were receptiveness, quickness of discernment. They had high esteem for lyric and narrative poetry, and possessed language of perfect form suited to express the various ideas which Nature might suggest to a pastoral people, and to portray the fiercer passions of the mind." Before the time of the Prophet, Arabia had clusters of inhabitants thus endowed. There were tribes, but there was no nation. There were peoples allied to each other by a common nature, yet driven apart by an independence born of wandering life and desert solitude. Mohammed made a nation, such a nation as was possible. Unity, in the full sense of that word, never obtained among this people. Yet they were so aggregated by the Prophet as to conquer the old world, to invade Europe, to threaten Christian civilization, to hold Spain for eight hundred years, and to pass through a most brilliant career in every department of human activity. Was there nothing ready to the Prophet's hand? Was there no preparation for the message "There is one God"? It is here at such points as this that we may find chief interest in historical movements. To trace living connections between the old and the new is alike the highest intellectual gratification and truest historical exposition.

Though the Arabian people were separated into tribes, and though these tribal distinctions were deep and permanent, there were not lacking certain points of connection. Had such comings-together been entirely wanting, nothing of all that happened could have happened. Between these Arabians, whether roaming over the desert or living in cities, two forces ever tended to bring them together: the one was religious, the other artistic. Mecca had been a sacred place to every dweller in the land from earliest times. Here, in soil utterly desolate, burst forth the magic well Zem-Zem. It offered its waters to Hagar and Ishmael. It had medicinal properties and miraculous virtues; the people came together, and Mecca was built. More than this, here was a sacred black stone, mysterious in origin and power. It was said to have come from heaven with Adam. Here Adam worshiped after his expulsion from paradise, in a tent sent from heaven. Seth substituted a structure of clay and stone. This was destroyed by the deluge, and rebuilt by Abraham. As it now stands in the mosque at Mecca, it was shaped in the year 1627. It is from thirty-five to forty feet in height, eighteen paces long, and fourteen broad; its door is covered with silver, and is opened but three times each year. This is the Kaaba. In its northeast corner, incased in silver, lies the black stone, toward which all the faithful turn in prayer. So much had religion done to bind these Arabs together. There was an artistic influence. "Poetry seemed the necessary expression of the passionate nature of this people. Poetry preserved the genealogies and rights of the tribes, as also the memory of great actions. A poet honored his tribe; in turn his

tribe and kindred tribes joined to do him honor." Every year, from all parts of this strange land, there was a gathering near Mecca. The poets recited their poetry, disputing for the prize, and the assembly determined the merits of the productions. Seven poems, each the work of a distinct poet, were thought worthy of special esteem. They were written down in golden characters upon Egyptian paper, and suspended upon the walls of the Kaaba.

Only one of these poems antedates the new faith; the author was contemporaneous with the Prophet. I make two brief selections from the first poem; in the one the poet is describing his steed, in the other a storm:

"Often have I risen at early dawn, while the birds were yet in their nests, and mounted a hunter, with smooth, short hair, of a full height, and so fleet as to make captive the beasts of the forest—a bright bay steed, from whose polished back the trappings slide as drops of rain glide hastily down the slippery marble.

"Even in his weakest state he seems to boil while he runs, and the sound which he makes in his rage is like that of a bubbling caldron. When other horses are languid, he rushes on like a flood, and strikes the hard earth with a firm hoof. He has the loins of an antelope and the thighs of an ostrich; he trots like a wolf and gallops like a young fox."

THE STORM.

"O friend, seest thou the lightning, whose flashes resemble the quick glance of two hands amid clouds raised above clouds?

"I sit gazing at it—far distant is the cloud on which my eyes are fixed. Its right side seems to pour its rain on the hills of Katan, its left on the mountains of Sitar and Jadbul. The cloud unloads its freight on the desert of Ghabeit, like a merchant of Yemen alighting with his bales of rich apparel.

"The small birds of the valley warble at daybreak, as if they had taken their early draught of generous wine mixed with spice."

A verse from the poem of Tarafa:

"I consider time as a treasure decreasing every night, and that which every day diminishes soon perishes forever.

"By thy life, my friend, when Death inflicts not her wound, she resembles a camel-driver who relaxes the cord which remains twisted in his hand."

From the poem of Zohair:

"I am weary of the hard burdens which life imposes, and every man who, like me, has lived fourscore years, will assuredly be no less weary. I have seen Death herself stumble like a dim-sighted camel; but he whom she strikes falls, and he whom she misses grows old even to decrepitude.

"Whenever a man has a peculiar cast in his nature, although he supposes it concealed, it will soon be known; experience has taught me the events of this day and yesterday, but as to the events of to-morrow I confess my blindness."

A later Arabian poet says:

"No sooner do I see a learned man, than I long to prostrate myself before

him and kiss the dust of his feet. Equally valuable are the ink of the doctor and the blood of the martyr. The world is supported by four things only—the learning of the wise, the justice of the great, the prayers of the good, and the valor of the brave."

Men who could feel and utter such truths might well have something to do in the world. On the 16th of July, 622 A. D., Mohammed fled for his life from Mecca to Medina ; eighty years passed, and Syria, Persia, Northern Africa were subdued, and the Moslem host stood upon the southern coast of the straits of Gibraltar, prepared for the conquest of Spain. Mohammed made a nation.

It were most interesting to obtain a philosophical account of this man's character and career. This is not, however, in the line of our present purpose. It is sufficient here to remember that monotheism was the one lesson taught the Semitic race. The original God-idea was One Being, God over all. It is very justly remarked that, in the opinion of Mohammed, this idea had been narrowed by Judaism : God had become the God of Israel. Again, this idea had been falsely developed by Christianity in her doctrine of the Trinity, and in her anthropomorphic Saviour. Directly opposed to both of these is the proclamation of the Prophet, "There is but one God, the Living, the Ever-living, the Holy, the Self-contained, and Mohammed is his prophet."

This pure monotheism recognizes no distinctions among men ; no Jews, no Christians, no classes—God is one God. Here is the source of Mohammed's power.

Our literature is filled with testimonials to the marvelous expression which Arabian culture received in Spain. There is no need to enumerate the schools of learning or the achievements of this people in every direction. I am confident that a few words from the Arabians themselves will do more than can be accomplished in any other way, to show their attainments in thought and feeling.

In Persia the faith of Islam became a mystical pantheism ; this finds beautiful expression in the lines of Rumi, who died in the year 1262 :

"I am the little sun-dust—I am the great sun-ball ;
To the little dust I say remain, and to the sun, pass on.
I am the morning's glimmer, I am the evening's haze ;
I am the wild leaves' moaning, I am the sea's high billow ;
I am the mast, the rudder, the steersman, and the ship ;
I am the physician, the sickness, the poison, and the antidote ;
The sweet, the bitter, the honey, and the gall ;
I am the chain of Being, I am the ring of worlds."

To this all-soul humanity should make complete surrender :

"Truly death ends life's need,
Yet shudders life 'fore death ;

Life sees the dark hand,
Not the bright gift which she offers;
So shudders before love the heart
As if threatened with destruction,
For where love awakes, there dies
The I, the dark despot:
Let him die in the night,
And breathe thou free in morning red."

In the year 1060 a prince, living on the southern shores of the Caspian Sea, wrote and gave to his son a book, called the book of Kabus. This gift was to represent better things than gold and lordly station. I translate, as before, from a German rendering:

"Know, my son, that this world which God created, he created according to his purpose. He did not create it in vain, but that his justice and excellence might be known; and he adorned it with the measures of his wisdom, for he knew well that beauty is better than ugliness, and wealth than poverty; that existence is preferable to non-existence, and abundance to destitution. Obey God and serve him—this is the first commandment which man has to fulfill. At the same time also honor thy parents. He who highly esteems his kindred highly esteems himself. From whomsoever thou mayst have sprung, know this, that it is better to be renowned for virtue than for inheritance. Honor is based upon understanding and good habit, not upon birth and fortune. Speak always courteously, that you may hear courteous answers. The reply for fools is—*silence*. Guard thyself against uttering falsehood; seek to be known and celebrated for the reliability of thy word. Under all circumstances forget not God in thy youth. Since it is indispensable to the great that they should be instructed from the very foundations of every subject, and since no one can derive profit from any art before he is acquainted with the hidden mysteries of the same, so consider, at first, the highest and most excellent of all sciences, the science of religion. Religion is a tree whose root is faith in one God and whose branches are the laws; knowledge of the one and of the other secures temporal and eternal advantage. Apply yourself, therefore, my son, to the science of religion, for this is the trunk of the tree of which the other sciences are but branches."

The prince now gives advice so practical, so wise, as to be worthy of application by all sons at all times:

"My son, dost thou desire to become a preacher, remember, when thou art about to ascend the pulpit and to preach, quarrel and wrangle not with those who sit beneath. Speak everything as thou willest, only have care that all be truth and no error. Speak elegantly and fluently, and hesitate not, but speak according to thy heart's desire. From pride, deception, from a sensual life, remain free. Know this, that what of good actions thou practicest thy people will also perform.

"Dost thou desire to become a judge, then must thou be courageous, sharp-sighted, quick of comprehension, and a man of sound judgment. Thou must know what thy case has before it and behind it; thou must be a judge of men. Thou must know the habits of every class of men, thou must see into their failings. Give to each cause much investigation and, reflection, and after thou hast

discerned the right decision, express it in few words that not a syllable further be needed. Above all things must the judge be honest, and his chief excellence consists in this, that he is learned and self-controlled, and keeps himself from forbidden things. Dost thou desire to become a physician? Then must thou learn the theory and practice of medicine. Thou must investigate fire, air, water, and earth. Thou must learn to distinguish the temperament, the sanguine, the choleric, the melancholy, and the phlegmatic, together with their related sources, the blood and the gall, also their corresponding principal organs. Thou must give attention also to the senses and their powers, seeing, hearing, tasting, smelling, and feeling; also to the inner powers, the imagination, memory, and reason; also to the animal powers, activity and repose. By the sick man himself lay thy hand upon the pulse.

"Dost thou desire to become a poet, so give heed that thy expression in the poems be clear and plain. Shun dark speaking; write not poetry without imagery, taste, or art.

"Dost thou desire to learn music, then must thou be well-habited and friendly, not of evil habit and ungracious. When thou comest into the company, be not always playing light songs and melodies, or always playing hard and difficult pieces. For the people assembled are not all of one nature, but are often quite opposed to each other; as generally men are not all of one taste. Therefore must thou be instructed in all forms of melody and various kinds of instruments, that all the people may receive pleasure.

"Lastly, my son, art thou called to be a ruler—guard thyself from all that is forbidden. Reach not out thy hand after another's possession. In all things thou undertakest, first seek to bring thy desire into harmony with thy understanding; then begin the matter. In no affair over-haste thyself, but when thou hast hit the fitting time then come to the work. In all things regard consequences—a ruler must be sharp-sighted, and consider the end. And whatsoever possessions thou mayst have, and whatsoever occupations thou mayst pursue, seek always to reflect upon the beginning and the end; seek to know eternity and to gain the honor of the virtuous, that, among all men, thou mayst be one of the most excellent."

These words show a culture of which no people need be ashamed. Were there power to apply their wisdom in our day, life would enter upon its fuller fruition, and men would be more helpful one to another, because more noble.

[*To be continued.*]

HEREDITARY DISEASES AND RACE-CULTURE.

By GEORGE J. PRESTON, M. D.

TO any one who will scan the human race, from the time when Greece and Rome were in their zeniths, down to the present day, it will be apparent that men have degenerated physically. We may have high examples, here and there, of some specialized feats of strength or skill, but, taking the races man for man, we are vastly inferior physically to the Greeks. One prominent cause of Grecian ex-

cellence occurs naturally to all, namely, the necessity for and the high premium set upon physical superiority. Among a people where "all were for the state," and patriotism was the ruling passion, each man held out his life to the state whenever she saw fit to use it, and the state took care that the sword-arm should be well developed. Gunpowder and the implements of modern warfare had not yet rendered all men equal on the battle-field. To have gained a prize at the Olympian games was enough to raise a man, and with him his family, from obscurity into prominence. As the race has progressed, the need for physical force has grown less and less, until at the present day the term physical force, or, as we oftener hear it, brute force, has almost become an opprobrious epithet.

A fallacious notion has somewhere crept in that an *intellectual* man must be below par *physically*, and that the one faculty is necessarily cultivated at the expense of the other. The old proverb, *mens sana in corpore sano*, has been flouted as an absurdity. So much, very briefly, for the first cause of race-degeneration; the second, and the one to which this paper would direct attention, is the influence of hereditary diseases. This factor has never received the attention it should have had at the hands of the writers on social science. The races of which we have been speaking had little of this element to contend with. The weaklings were either deliberately exposed and left to die, as in the case of the Spartans, or if they attained maturity they were held in such low esteem that they willingly kept in the background. Look for a moment at our modern civilization, and mark its diametrically opposite tendency. Every day hospitals are being erected to nurture the diseased and imperfect specimens of our race, and every year thousands of children are by skill and care saved from the death to which Nature would consign them. All this accords with our enlarged notions of humanity, and reflects great credit on the zeal of the philanthropist and the science of the physician, but it exerts a baneful effect on the race. To one who has had access to any large city hospitals, it is a pitiful sight to see the multitude of children who are tided over a few years, and sent out into the world branded with an hereditary taint, to propagate their wretched breeds. The limits of this paper will not allow any extended statistics, nor the nature of it warrant a special discussion of hereditary diseases, but there are two whose effects are apparent to all, consumption and insanity. The former, consumption, using the term in its widest sense, has for ages produced the most frightful ravages. For example, in England, from 1837 to 1841, of the total number of deaths from all causes sixteen per cent were from consumption. In Philadelphia, from 1840 to 1849, the death-rate was one of consumption to six and a half from all other causes, or about fifteen per cent.

Of late years, however, the mortality has been somewhat reduced by a more successful plan of treatment. As regards insanity "in the

different civilized nations of the world, there is an average of one insane in five hundred inhabitants. The undoubted steady increase of the insane under care and observation would seem to be greater than can be fairly accounted for by the greater attention now given to their welfare" (Maudsley). These two instances, recognized as the most important in the hereditary class, will serve as examples; it is not desired here to show in what proportion of cases disease is transmitted from generation to generation; the writer hopes to be able at a later date to give some general laws respecting hereditary affections.

The *heredity of genius* has been fully proved by that very interesting writer and accurate observer, Francis Galton, and he has put forward in a masterly way the claims of *eugenics*, or race-culture. This must be effected, he urges, by a rational system of natural selection. "Men," says the same author, "have long been exempted from the full rigor of natural selection, and have become more mongrel in their breed than any other animal on the face of the earth." The laws of natural selection, considered broadly, prevail among men more than at first sight appears.

Among the lower animals, as Mr. Darwin has shown, strength, beauty, voice, and such qualities, determine a choice: the rustic maiden often chooses her husband because he is stronger physically than his rivals; the more intellectual woman would naturally look for mental superiority, and so on. Now, the strongest point in any rational natural selection must be first and foremost pure blood; and by that is not meant blood that has come down through a long line of ancestors merely, but blood which is free from any hereditary taint. We are all familiar with the member of some "old family," a slight, flat-breasted, precociously intelligent child, whose slender, graceful neck, bright eyes shaded by long lashes, thin, white skin through which the blue veins show, declare to the educated eye the presence of tubercular disease. We know that, if such a child matures, the odds are overwhelming that its offspring will continue to disseminate the disease. Or take any number of insane persons, with whose family history you are more or less familiar, and the certainty with which you will be able to trace the disease to hereditary predisposition is wonderful. We know of no government sufficiently strong to forbid the banns of a man whose lungs are full of tubercle, or of a woman upon whose person cancer has shown itself. The only way to begin to stamp out hereditary disease is to direct the tide of public opinion toward it. We would not if we could enforce the Spartan rule, but we can and should exert a power they knew not of, the press, and educate our people to the full importance of this subject. Even our proverbial *mauvaise honte* can not object to showing the young of both sexes the horrors of a legacy of an hereditary disease. Those who are to become the fathers and mothers of our next generation should be warned before they make a step into the dark, and should

feel that it is a duty they owe, not only to themselves, but also to their country, to propagate a pure race. It is repugnant, at first thought, to speak of "breeding" men and women, but this very repugnance to handling a subject surrounded by so much delicate reserve has been largely conducive to the race-degeneration. We know that the race should be improved; every year, as has been shown, pours its rapidly increasing mass of impure blood into the general current. A man with one or more hereditary diseases on his side, and a woman with a like number among her ancestry, make it almost impossible for their offspring to escape.

We know that the race can be improved, as is shown by analogies among the lower animals. How paradoxical it seems that a man who would scout the idea of breeding his stock to diseased animals should yet without a word of opposition see his children marry into families where the hereditary taint is marked. Yet such is undoubtedly the fact. Ignorance must be the prime cause of much of this misery; for the certainty with which some diseases reproduce themselves in succeeding generations is a fact which can be proved, and not a mere set of coincidences as many suppose.

The theory that healthy blood on one side of the house is sufficient to counteract the diseased of the other is, unfortunately, fallacious. The predisposition to hereditary disease will often survive many influxes of pure blood, and the currents may, like the clear and sparkling Rhone emerging from Lake Geneva, and the dirty-gray Arve from the glaciers, run side by side for a while, separate and distinct, but at last they mingle, forming one turbid stream.

EVOLUTION IN ARCHITECTURE.

By FRANCIS H. BAKER.

THE disciple of Darwin labors under one disadvantage. The periods necessary for maturing the changes which he investigates being so immeasurably superior to those relating to ordinary mundane affairs, he can not verify the sequence of the events by the independent testimony of contemporary history. It would be interesting to apply the theories of development and natural selection to some department of knowledge in which we could have that aid.

Human society is so largely subject to the influence of emotions which appear to have little or nothing in common with the orderly operation of natural laws, and its course is so checkered with action and reaction, that it is often difficult to follow any particular line of progress for a length of time. Examples of regular development are, however, not wanting, and one of the most striking is to be found in the history of architecture. To a person ignorant of such history

there would appear to be no connection between a Gothic cathedral and a Greek temple, beyond the facts that both were buildings of stone, and both had been dedicated to religious worship; yet that one has been evolved out of the other is a matter of simple demonstration. We can supply all the links of the chain by referring to edifices still standing, the times and circumstances of the erection of many of which have been detailed by the general historian.

To find the source from which the European nations have derived the art of building in stone, we must look to the land of the Pharaohs. From Egypt the craft passed to Greece, and from the Greeks it was taken up by the Romans, to be by them disseminated through the north and west of Europe in the process of colonization. The similarity, in regard to the constructive parts of the ancient Greek buildings to some of those found in Egypt of older date, affords strong confirmation of the tradition that the Greeks borrowed the art from the Egyptians. The Greeks, however, in adopting it added a new feature, the pediment, and the reason for this addition is easy to find. Egypt is practically rainless. All the protection from the climate required in a palace or temple in such a country is shelter from the sun by day and from the cold by night, and for this a flat roof, supported by walls, or pillars with architraves, is quite sufficient; but, when, as in all European countries, rain has to be taken into account, a slanting roof becomes a necessity. The Greeks, with their eye for symmetry, provided for this by forming the roof with a central ridge, at an obtuse angle, from which it sloped down equally on either side. The triangular space thus formed at the end of the building above the architrave was occupied by the pediment, and this part of the façade, which owed its birth to the exigencies of climate, was thenceforth regarded as so essential to the artistic completeness of the work that it was said that if a temple were to be erected in the celestial regions, where rain would not be possible, the pediment could not be omitted.

Both the Egyptians and the Greeks were satisfied with bridging over the openings of doors and windows, and the spaces between columns, by means of the architrave, a mode of construction which involved the necessity of using long blocks of stone. But the Romans, whose enterprise took a wider range, were not content to labor under such restrictions. In their engineering works they were familiar with the principle whereby blocks of comparatively small size, arranged in a semicircular form, can be made to hold together without support from beneath, except at the two ends of the series, by being arranged in the form of a semicircle; and, applying this principle to architecture, they not only gave to art a freedom it never before enjoyed, but conferred on it a new element of beauty. The arch, unknown to the Greeks—or, if known, not made use of in their temples—and employed by the Romans in the first instance from utilitarian motives, has ever

since been an important, often the most important, feature in architectural works.

The Roman architect was thus in possession of all the constructive elements—pillar, architrave, pediment, and arch—which distinguish an architectural edifice from a building merely made up of walls and a roof. Without speculating as to the origin of pillar and architrave, with their subsidiary elements of plinth, capital, cornice, etc., it is clear that the last two—the pediment and the arch—resulted from the pressure of new and external circumstances. Into the history of the orders we need not enter. Their function is that of ornament, and the choice of their forms was probably governed by considerations of taste rather than the requirements of situation. The classic architecture in the best examples presents all the characteristics of a finished and matured art; and if the old civilization had been maintained, in the old places, though an additional order or two might perhaps have been invented for the sake of variety, there is no indication that there would have been any important change in the style of building. The disintegration of the Roman Empire, however, and the triumph of the barbarians, brought into play an entirely new set of forces, and prepared the way for that wonderful series of beautiful and ever-varying creations which we know by the name of Gothic architecture.

Can we discover what it was that inspired the mediæval builders in the production of forms of so much beauty, often at times when all other arts were dead and gross ignorance abounded? One consideration may help us. The periods of the Gothic styles (including those which led up to the styles to which the term is sometimes restricted) are precisely those which are called the *dark ages;* and in the successive changes through which the art passed in those ages can we not perceive a *yearning for light*—light in a threefold sense—religious, artistic, and physical?

1. Moral or *religious* light. An upward tendency now begins to manifest itself. There is an evident disposition to make the buildings appear as if springing up from the earth, instead of resting upon it. In the temples of antiquity all the principal lines are horizontal, in agreement with the surface of the earth; in the mediæval buildings the tendency of the prevailing lines is to assume a vertical position, pointing heavenward.

2. Artistic *lightness.* The Greeks and Romans appear to have paid little regard to economy of material in the construction of their public edifices. Many of their works seem to rely for their effect chiefly upon their massive grandeur. But the Gothic architects seem to have been distressed with the weight of the material in which they worked. They found means, from time to time, to diminish its weightiness, in appearance at least, by diapering, molding, and tracery.

3. *Physical* light. Under the semi-tropical skies of Southern Europe, little regard had to be paid to this blessing, beyond providing

against its excess. On the removal of the centers of civilization northward, the openings for the admission of the light of day became objects of solicitude, and thenceforth the windows are the principal parts of the wall in which they are pierced.

A naturalist of the new school might describe to us the changes which would be induced in a plant or other organism translated from the sunny climate of its birth to the cold and murky atmosphere of the north, and surviving, by virtue of its "fitness" for a place in its new home. Let us follow, as rapidly as possible, the behavior of the art of building in like circumstances. In doing so we may conveniently take the examples to be found in our own island; for, although the Gothic architecture prevailed throughout the greater part of Europe during the middle ages, it ran its course with greater regularity, and for a much longer period, in England than on the Continent. Owing chiefly to its geographical position, this country was the first to lose the connection with imperial Rome, and the last to feel the full force of the Renaissance.

The first effect of the new state of things was in a direction completely opposed to the aspirations to which we have referred. The general sense of insecurity which followed the withdrawal of the Roman legions made the strength of their walls the first care of the early builders, and windows and doors were necessarily reduced to the narrowest dimensions. Hence the heavy character of the styles denominated Romanesque, represented in this country by Saxon and early Norman works. The relative measurements established by classic taste were everywhere ignored by the Christianized barbarians; and, if even our rude Saxon forefathers could have appreciated them, they must have been abandoned through necessity. There are no complete buildings in this country which can be pronounced with certainty to be genuine Saxon works. For a description of the buildings of that period we are dependent on the accounts of early writers, aided by fragments which have been incorporated with works of later construction. The Saxon churches are described as low, small, and mean, with very thick walls, and floors sunk below the level of the ground.

For four hundred years our ancestors endured these dark, dismal stone erections—that is to say, where they enjoyed the luxury of a stone church, for probably at that time most of their religious buildings were, like their houses, of wood. Two interesting features, however, relieve this dreary period. One is the triangular-headed window, a remarkable anticipation of the pointed arch; and the other, the insertion of a small pillar in the center of some windows, which is evidently the forerunner of the mullion. An excellent example of a window in which both these peculiarities are combined is to be seen at Barton-upon-Humber. The date is about A. D. 800.

Toward the end of the tenth century a first step was made in the

direction we have indicated, by raising the central portion of the building above the roof, in the form of a low, square tower. This served as a lantern for the admission of light. In the eleventh century, when the Norman period commenced, the upward tendency was much more marked. The buildings generally were more lofty, and the tower especially was heightened. The splaying of windows—a device evidently brought about by the desire to obtain the maximum of light through the narrow openings in thick walls—now became general. The early Norman buildings retain in general the Romanesque character of massiveness, but efforts to relieve this are apparent in the rich carving of doorways, the occasional wreathing or other decoration of heavy supporting pillars, and the use of light arcades for mere ornament. The circular section of the pillar is no longer strictly adhered to, but hexagonal and octagonal pillars are freely used, and sometimes four shafts are combined into one pillar, the commencement of the clustered form so conspicuous in later styles. But the most important invention of this period was the buttress, which rendered it possible to raise the height of a wall considerably without the necessity of adding uniformly to its thickness.

In the twelfth century architecture began to develop in well-defined forms the peculiar character which we distinguish by the term Gothic. With the view, doubtless, of providing more effectually against the inclemency of northern climates, the pitch of the roof had been raised, until, at the time to which we refer, the ancient pediment had grown into the mediæval gable. Another important change was the introduction of the pointed arch. Of the writers who have put forward their own particular views as to the origin of the pointed arch, it may be said their name is legion. The theory that it was suggested by the interlacing of the branching of trees is a pretty one, but, we fear, must be relegated to the domain of poetic fancy. It would have had more force if it could have been applied to classic architecture, and not to Gothic, as the worship in groves intimately connected with paganism, whereas the Christian religion is associated in its early days with caves and catacombs. The hypothesis that it is an importation from the East, one of the results of the Crusades, has much to be said in its favor. Pointed arches had long been used in Oriental buildings, and they are even found in Assyrian remains. The intersection of arches carried to alternate pillars in ornamental arcades—a form frequently met with in Norman buildings—produces a perfect pointed arch. But whatever was the immediate cause of the adoption of this form, it is an expression in a high degree of the principles which governed the development of the art in the middle ages. It marks a distinct advance in the pursuit of light, in all the three senses mentioned above. Not only is the central portion higher than that of a semicircular arch, but the construction is such as to suggest that the support of the pillar is carried upward through the

imposts into the arch itself, instead of the force being directed downward, as in the Roman arch.

The pointed arch made its appearance in the several countries of Europe almost simultaneously, but it took nearly a hundred years to entirely supplant the round arch. During that time pointed and round arches were used indifferently in the same building, as occasion might require or taste dictate; but in the thirteenth century the pointed form was finally established. Another change is now apparent, showing the application of a principle which, perhaps more than any other, distinguishes the best examples of Gothic architecture—a desire to rely for the beauty of the work on the form and arrangement of the constituent parts, and to make it as independent as possible of added decoration. This is evidenced by the deeply cut moldings, in continuous lines, strongly marking out the construction, which are so noticeable in what are called "Early English" buildings. More lightness is also obtained by means of clustered pillars, molded arches, tracery in the windows, and especially by the use of buttresses. The buttresses, first used to give additional strength to an already substantial wall, were completely altered in form. Instead of being, as in the Norman period, broad and flat, projecting but slightly from the surface of the wall, they were now placed with their breadth at right angles to the wall. They were also lightened by being divided into stages, and divided in their lower parts by arches. By this arrangement the weight of the roof and upper portions of the building was transferred to points outside the walls, and this enabled immense progress to be made in the light-seeking principle by leaving a much larger portion of the sides of the building available for windows.

The art having now assumed a definite and decided character, the succeeding varieties of style show a steady progression on the lines established. The simple pointed arch was formed by describing it from two centers instead of one; by using more centers, trefoils and quatrefoils were obtained, and the intersection of the circles produced the cusp, another form of point. Points now appear everywhere; buttresses are prolonged into pinnacles, and towers are surmounted by spires. Ribs under arches and vaults are multiplied, to distract the eye from the weight of the material which they appear to support. Horizontal lines and divisions gradually disappear, or are broken up, until in some cases there is no line to mark where wall ends and roof begins. Even the beautiful geometrical forms of the fourteenth century had to give way to the perpendicular, which in the fifteenth century reigned supreme.

As an example of mediæval architecture at the highest point of development it was permitted to reach, we may take the chapel of King's College, Cambridge, one of the finest specimens of advanced Gothic art in Christendom. On entering the chapel the prevalence of the upward principle is at once apparent. On either side innumerable ver-

tical lines lead the eye upward from the richly decorated ground-panels to the gorgeous walls, which are of crystal, for the stone-work is seen only as the framing of the glass, as the division between the windows. The light of day is not admitted plain and undivided, to show up fresco or canvas, but, resolved into its constituent colors, it is forced itself to paint, in rainbow tints which no surface pigment could produce, the chief events connected with the religion of the worshipers. First we see depicted the scenes of old Bible story. Past these pictures—through them—the lines flow up, and show us the corresponding incidents and revelations of the New Dispensation. Type is succeeded by antitype, and the dim teachings of the Law are seen perfected in the clear light of the Gospel. Still upward fly the lines. Drawn in dull, heavy stone as they are, they can not lead us up to heaven, but, having helped to point the way, they divide into branching curves, and bound our upward vision with a canopy or roof of spreading fairy fans. This roof is really a vault of solid masonry, in some places more than three feet thick, yet there is not a single pillar to indicate that it needs support from below. Not an inch of the material is hid, but by simply chiseling its surface the ponderous mass is completely veiled by the cobweb texture of the tracery. To appreciate the solidity of the structure, we must ascend and inspect the rough upper surface of the stone. Only then do we become sensible of the weight of the huge blocks, some of them weighing over a ton, which, by the masterly system of vaulting, are made, simply by the force of their own gravity, to bridge over the awful abyss beneath. To find the source from which the enormous weight of this roof derives its support, we must go outside the building and examine the buttresses which flank the building on either side. The strength of these is not apparent at first sight, for the lower parts, of course the most massive, are massed by connecting walls, and the intervening spaces thus inclosed are utilized as chantries, leaving only the upper and lighter portions visible. On comparing this chapel with some of the richest Italian interiors, the peculiar character of beauty already referred to as distinguishing Gothic art is at once perceptible; the decoration, instead of being superadded, is bound up with the construction; the parts themselves are made to provide the ornament. From an æsthetic point of view this noble chapel is a consummate work of art; as an example of mechanical ingenuity it is a triumph of engineering skill.

This work was commenced in the middle of the fourteenth century, but not finished till the fifteenth century was far advanced. By this time, however, there were unmistakable signs that the reign of the upward-pointing principle was drawing to a close. Arches were depressed, right angles abounded, and square-headed windows were used, not only in situations where they might be convenient or appropriate, but in such important positions as the east end of a cathedral, as at Bath Abbey.

The perpendicular style was peculiar to England. On the Continent the fifteenth century gave birth to a variety of "after-Gothic" styles, mostly remarkable for extravagance and want of taste, and which speedily disappeared before the classic form which had already been revived in Italy. In this country, however, Gothic architecture died hard. The English art continued to maintain its individuality for fully a century, though deprived in a great measure of its elevating spirit. The Tudor or Elizabethan manner, though very successful in baronial mansions, and peculiarly applicable to "domestic" purposes, has a distinctly "debasing" effect when applied to ecclesiastical edifices. The growing influence of the Renaissance also, in the attempts to graft classic ornaments and composition on mediæval forms of construction, produces often a mongrel effect. In a word, the natural development of architectural art was arrested. Before the end of the seventeenth century the triumph of the Italian school was complete. The mediæval art was opprobriously branded with its present name of Gothic, and the sublime fanes which it had produced became, in the language of Sir Christopher Wren, "mountains of stone, huge buildings, but unworthy the name of architecture." The feeling was, in fact, that we had been traveling along a wrong path, and should return to the point at which the art was left by the Romans.

At the present day the classic and the mediæval modes have each their partisans. We will not here attempt to discuss the merits of the rival styles. We will only point out that while the classic art embodies the finished conceptions of the ancient schools of thought, the Gothic is associated with the chain of events which mark the struggle for national liberties. The one represents satisfaction with an existing state of things, the other progress toward an ideal. Having won our liberties, we can study in peace the laws and usages of by-gone ages. Having solved the problem of adapting the ancient art of building to the requirements of modern times, we can indulge our fancy in the selection of our models.—*Gentleman's Magazine.*

INDIAN MEDICINE.

By G. ARCHIE STOCKWELL, M. D.

THOUGH it speaks little for modern civilization, the masses of the people are wont to esteem the savage as preternaturally wise in the secrets of Nature, more especially in the prevention and elimination of disease, accrediting him with knowledge botanical, pharmacal, and therapeutical, that if possessed of but a shadow of reality would be little less than divine. In this we have interesting evidence of man's tendency to reversion, and of lingering attributes of the final state of his awe in the presence of the occult, and inherent worship of the

unknown; for how frequently one encounters, in all ranks and classes of society, individuals who, in spite of refined teachings and surroundings, exhibit an unmistakable taste for charlatanism in some of its many forms, secular and spiritual!

"Medicine" as exemplified among the savage races and tribes of America is practically one and the same with the "shamanism" of the European and Asiatic nomad, the "fetich" of the native African, and the "obi-rites" and "voudoo-worship" of West India blacks and negroes of the Gulf States; a careful examination of all reveals not only a common origin, but a unity of purpose.

The "medicine" of the Indian is his religion and philosophy; and it comprises everything in life and Nature, real or imaginary, superstitious or occult; and withal it is a mystery so subtile in its many factors as utterly to defy specific definition, or perfect elucidation.

The "medicine-man" is no more a physician, in the modern and enlightened acceptation of the term, than an ape is a man because it chances to assume the erect posture and mimic the attributes of the human race; there is a slight analogy, but nothing more. The savage knows absolutely nothing of the relationships existing between cause and effect, of the action of remedies *as* remedies, of physiological conditions and phenomena, or indeed of any agency that is not directly born of the occult. He supposes the world and its circumambient ether to be permeated by spirits, good, bad, and indifferent, who determine the fortunes of men and regulate the phenomena of Nature in accordance with individual will and fancies; and who also bear some mysterious and indefinable relationship to each other, and to one "Great Spirit" or *Supreme Power* who figures under a variety of guises and titles, according to circumstances and surroundings, such as "The Old Man," "Nine-bouzche," "Si-ce-ma-ka," "Kitche-Manito," "Great Manito," etc. Manito, Manit, or Manitou, however, is not an appellation alone singular to the *Supreme Power*, but under certain conditions is equally applicable to any and all spirits; in other words, it may be used *generically* as well as *specifically*. Then, too, there are certain sprites or gnomes, "Little Men," invisible dwarfed inhabitants of portions of the earth, who would seem to be satellites of the spirits proper, but whose position in savage demonology is by no means satisfactorily defined.

Good spirits receive little attention, and are never objects of worship, since their acts, influence, and purposes are obviously for the best. But the evil and half-way malevolent demand constant supervision and placation, lest the smooth workings of Nature be interfered with, and the normal destinies of man perverted. A journey through the Indian country affords ample evidence of this belief in frequently recurring offerings suspended from trees, bushes, and wands, or conspicuously exposed upon rocks, knolls, and open places, such as broken

or discarded glass, metal and bead ornaments, shreds of skins, bits of painted leather, bright ribbons, strips of gay calicoes, feathers, pieces of tobacco, and bundles of human and animal hair.

The true "medicine-man" (for there are charlatans and pretenders* in savage as well as civilized circles) is one of a fraternity most mysterious and despotic in its ways and workings, membership therein being limited to those who exhibit more than ordinary fitness therefor, backed by powerful family and tribal influence. In one sense "medicine" is an autocracy; and it is also the nobility of the savage, no way limited by tribal power, and is forbidden to women except for very extraordinary and specific reasons. Its apprenticeship, too, is long and arduous, beset throughout by trials and stumbling-blocks, calculated to tax to the utmost the patience, faith, endurance, and fortitude of the candidate, and to betray the inner consciousness and latent foibles of the individual. Having passed the prescribed ordeals, he is admitted into full fellowship amid ceremonies calculated to be most solemn, impressive, and binding. One of the labors prescribed, and frequently performed in public on the evening of the annual "goose-feast," is as hideous as it is sickening. It consists in devouring a live dog, and is a proceeding that especially obtains among the Chippewyans, Crees, and Ojibways; and a more horrible or fiendish scene, as viewed by the flickering fire-light amid sounding drums and rattles, the shrieks of the victim, and the frenzied howls of the assemblage, can not be imagined.

Disease, from a savage standpoint, is not a mere morbid phenomenon, but the specific manifestation of some demon or spirit of evil, who through a kind of occult intelligence or agency has obtained control of the person; and, naturally, relief is deemed possible only through agencies that have their inception in the miraculous and supernatural. Under such circumstances the most absurd ideas obtain both among laity and fraternity, and remedial measures are irrelevant, crude, and not infrequently most barbarous. Think, for instance, of the fauces, including the soft palate and muscular tissues of the throat, being forcibly wrenched out by a pair of bullet-molds in the hands of an "Indian doctor" or medicine-man, and for the relief of a tickling cough due to an elongated uvula! Such is a veritable occurrence; and yet the operation was not due to an appreciation of the difficulty, but was intended to dislodge a spirit that had taken possession of the part! It is perhaps needless to remark that it was successful, in that it not only dislodged the spirit of the disorder, but that of the sufferer as well.

All medicine-men of first rank are clairvoyants and psychologists (mesmerists, if you like) of no mean pretensions, as a rule capable of

* Many an individual, renowned as a warrior and respected at the council-fire, becomes the jeer of his tribe because of his pretensions to "medicine," which have not been legitimately acquired, or of which he is not possessed.

affording instruction to the most able of their white *confrères;** and to be a medicine-man at all demands that the individual be not only a shrewd student of human nature capable of drawing deductions from matters seemingly most trifling, but also an expert conjurer and wizard. I have repeatedly known events in the far future to be predicted with scrupulous fidelity to details, exactly as they subsequently occurred; the movements of persons and individuals to be described in minutiæ who had never been seen, and were hundreds of miles away, without a single error as to time, place, or act; and I have witnessed feats of legerdemain and necromancy that would appall a Houdin or a Heller, executed in broad daylight, without mystic aids or surroundings. I have seen guns, manifestly in perfect order, fail to execute their mission while in the hands of most expert marksmen, merely through a look, a touch, a word, or a bit of incantation; and yet again restored by a like process.† But here, as may readily be surmised, the trouble was not with the weapon, but with the man behind it, whose will-power was not equal to the task of overcoming his native and inherent superstition. Again, it has been my fortune to witness feats so astounding that I dare not place them upon record lest I be accused of romancing; some, to be sure, susceptible of explanation under physical and psychical laws; others not so easily or satisfactorily disposed of, except perhaps as tricks of the imagination, "optical delusions," etc.; and even as to these few would be willing to admit that, of an audience numbering some scores, all could be successfully deluded.

Having already intimated that the Indian relies chiefly on incantation and conjuration to produce specific effects, it is readily understood that success is due to the impressions produced upon the great nerve-centers. Just as the ancients esteemed the ear and nose the highways and emunctories of the brain, the special senses of hearing and smell become the foundation of all savage physiology, and consequently are appealed to in the most emphatic and comprehensive manner. Noise and odor are ever the prime factors in the *armamentarium therapeuticum* of the medicine-man, and it is no exaggeration

* The Indian recognizes the fact that clairvoyant and psychic power may be inculcated and developed *de novo;* that it may be brought about by certain conditions that stimulate, or disarrange and disorganize certain nerve-centers, and he consequently prepares for more formal and eventful measures by fasting, long vigils, and other acts that develop extreme nerve-sensibility. A white man I once knew always developed extraordinary psychic and clairvoyant powers during or just subsequent to a prolonged alcoholic debauch that had been accompanied by excessive sexual indulgence, *and at no other time!*

† Horses and men have been known to lose control of their limbs through the machinations, incantations, etc., of a medicine-man. One case known to me was that of a famous Indian runner, who was deprived of all save ordinary use of his legs. Another case was that of a stallion invaluable to its owner as a buffalo-hunter, which became practically useless until it passed into the hands of a hard-headed, non-superstitious Scot, when it suddenly regained its powers!

when I assert that whole families, especially during the ravages of epidemics, are frequently and literally drummed, rattled, stank, and powwowed out of existence. Conceive of a child with its peculiarly sensitive nervous organization, prostrated with burning fever, kept in a close and stifling atmosphere and subjected to combinations of sounds and smells fit to launch an adult in full tide of health into the very depths of lunacy! Why, the din is so very infernal in character, the odors so intensely nauseous and suffocating, that the wonder is that *any recover.* Seemingly the most obstreperous of spirits, even the "Old Harry" himself, would be forced in self-defense to stop ears, clap fingers to nose, and flee to the uttermost confines of space!

The demonology of the red-man seemingly provides for various classes of spirits possessed of like attributes (but more exaggerated) with man. Some are strong, bold, persistent, revengeful, malevolent beyond measure, and but sparingly amenable to discipline. Others, again, are mild, weak, vacillating, forgiving, indifferent, easily placated. One of the latter may be got rid of, sometimes, with little trouble and ceremony; but an old and accomplished individual not infrequently demands the combined wisdom and efforts of a dozen or more conjurers, while days and even weeks may be consumed ere a successful (or fatal) issue is reached. Then there are various creeds, or articles of faith, that would appear not to be definitely settled (theologians and physicians the world over will disagree!), and it is a somewhat mooted question as to how the evil ones are disciplined, and whether they are coaxed or frightened from their hold upon the victim, altogether annihilated, or amenable to all three measures. In one thing, however, the fraternity is united; in any event, the treatment is the same!

The medicine-man is no sooner summoned, than he begins to enact the part of a *leech* in very truth. Above all things, he must feast, and that, too, almost incessantly, and upon the very best the surroundings afford, else he can not sustain the strength necessary to a struggle with the denizens of the spirit-world; and it frequently happens that not only the family of the sufferer, but all his blood relatives even to the most remote degree (and this is enforced by a very nice point of savage honor), are thereby rendered hopelessly bankrupt!

An examination, to determine the condition of the sufferer, is not at all essential, since the conjurer possesses an infallible means of diagnosis in the charms and amulets that stuff to repletion the "medicine-bag" that is constantly worn suspended from the neck; through these he derives power to mingle with the inhabitants of the unseen world, and to bring before his mental vision the entire physical and spiritual economy of any individual of earth or air at will. Summoning to his aid an assistant or assistants, he proceeds to his incantations without the least questioning or circumlocution, beginning with a low, monotonous chant rising and falling with abrupt inflections, wherein he begs,

implores, and commands the spirit to abjure the mortal clay and assume his own proper form, alternately humoring, coaxing, and threatening, as circumstances seem to demand, at the same time using set songs whose significance is unknown outside of his own mystic calling. In the mean time a running accompaniment is kept up by means of drums, bells, and gourd and parchment rattles. By-and-by the song waxes louder and more violent; the drums are pounded harder and faster, and the rattles and bells are shaken more forcibly. Higher and higher the sounds rise; shriller and shriller his voice is pitched; and faster and fiercer the accompaniment sounds, until the one becomes a frantic shriek, the other a pandemonium of most fiendish character, together crazing, piercing, and excruciating beyond computation; and, finally, exhausted by the violence of his efforts, fairly black in the face, with perspiration streaming from every pore, he pauses and—EATS! A starved wolf is a miracle of satiety by comparison; and he is ably seconded in his gormandizing feats by the assembled and admiring audience.

Over and over again is this performance repeated, while the smoke and fumes of burning gunpowder, fish-entrails, human excreta, buffalo-chips, and animal hair,* fill the interior of the lodge to suffocation, producing *stinks* that may fairly be *felt*. And, finally, when the excessively tormented and vexed spirit is sufficiently placated or frightened, and on the point of departure, his exit is facilitated by rapidly recurring discharges of musketry in and about the dwelling and over the body of the sufferer. When the friends are sufficiently wealthy, the fusillades are frequently prolonged for hours or days, to prevent a return of the (demon) malady.

But the spirit does oftentimes return in spite of every precaution; for naturally a relapse is coincident with the cessation of the incantations and the departure of the "medicine-man," or rather with the subsidence of the nervous excitement induced by such extraordinary procedures. Such unfavorable result matters little, however, as the superstitions inculcated render the officiating conjurer practically unassailable. It is to be expected that a demon or spirit imbued with a proper amount of pride and self-respect will return with the first opportunity, requiring new and perhaps varied incantations. The stronger and more persistent the demon, the greater evidence of power on the part of the medicine-man. Everything is made to redound to his credit; consequently, the spirit is effectually disposed of only when sufficiently bribed, thoroughly overreached, or utterly annihilated—only when Nature comes to the aid of the unfortunate and affords the necessary

* Certain creatures, of the *Mustelidæ* and *Canidæ* especially, are esteemed *medicine*, such as the beaver, mink, fisher, marten, musquash, skunk, otter, weasel, wolverine (*very powerful medicine*), dog, fox, wolf, moose, bear, musk-ox, bison, rattlesnake, blacksnake, puma, lynx, sturgeon, cat-fish, and lake sheep's-head (*Haplodonitus grunniens*)—"*great medicine.*"

relief, or death intervenes and claims his victim! If a fatal issue results, numberless excuses, always most reasonable, are at hand. There may have been a *new* spirit, or the Supreme Power may have interfered in behalf of the *old*, decreeing that it should work its full will, probably in retaliation for some vow made in the remote past and neglected or forgotten—hence, a just punishment! Under any circumstances nothing remains to be said, and the philosophy proves most satisfactory and comforting all around. One thing, the Indian *never changes* "*doctors*"; and, if another conjurer is summoned, it is always by or in consonance with the wish of the one in attendance.

One "powwow" that I witnessed among the Ojibways—my first experience by the way—engaged the talent of no less than a dozen "medicine-men" and nearly double the number of tyros still in their novitiate. Gathered from remote distances and points wide apart, some coming more than two hundred miles, they rallied under the leadership of one most famous in his day, so much so that his reputation traveled far beyond the precincts of his tribe; and, when gathered together, a more grewsome and spookish crew it would be difficult to imagine outside of Pluto's especial domain.

The leader or "great man" certainly deserved the distinction accorded him, if for no other reason than size and stature, he being a veritable son of Anak, considerably more than a "Saul among his people," and above thirty stone in weight. He was gorgeously figged out, and presented all the extremes of savage grandeur and frippery. From his shoulders hung a massive robe of black bears' skins lined and elaborately trimmed with scarlet; fringed blue-cloth leggins, a miracle of beaded work, and moccasins of caribou-skin ornamented with the same and with the dyed quills of the porcupine, clothed his nether extremities; ornaments of metal, of glass, of wampum, along with little bells, were artistically draped and hung from every available point; an elegantly wrought "medicine-bag" of mink-skin, and a large silver medallion of "her Most Gracious Majesty" hung suspended from broad ribbons about his neck; paints of various colors, green and vermilion predominating, daubed with no sparing hand, hid the natural hues of flesh wherever exposed; and, to cap all, his crown supported the head of a wapiti stag or Canadian elk, prepared in life-like manner as a helmet, and surmounted by immense antlers more than five feet high. Gurth's "Visions in Dreamland" ne'er produced so wild a "huntsman," or figure more Satanic; and, all in all, the costume was as striking and *bizarre* as one could ask to see.

His following were in a general way his humble imitators, but less grand and imposing. All displayed marked originality and taste in producing the hideous and striking. There was, of course, a profusion of unique ornaments and of paint, distributed with a view to the effect that might be produced upon patient and audience, and varying and bewildering results were obtained. One had his face completely

hidden with transverse bars of yellow and vermilion, and a ring of black about the eye; a second had daubed his countenance with black, painting the orbits white; another employed white and black in alternate horizontal bars, with eyes set in a deep border of bright vermilion; still another hid his face behind a mask of ochre; and a fifth wore a wolf-skin robe, the head of which supplied a covering for his own. The acolytes, or assistants, save for the instruments they bore, and the medicine-bags suspended from their necks, differed little from their brethren of the laity.

The scene was night, close upon the "witching hour"; the place a natural opening, less than thirty yards in diameter, in the midst of spruces, cedars, and towering Norway pines; a bright moon threw but fitful gleams of light, the rays straggling in here and there only serving to render "darkness visible"; even a small fire kindled near the center in no way tended to disperse the gloom of the surroundings, its beams but magnifying all within their radius into ghastly shades and shadows that danced fitfully and spectrally over the dark evergreen background, giving the solemn and weird character demanded in such proceedings, aiding to impress the beholders with the idea of the mysterious and supernatural.

The unfortunate in whose behalf the medicine* council was instituted was a man just past the prime of life, who but a short time before had been stricken with paralysis that involved in varying degrees the entire right half of the body; the hand and arm were entirely dead to sensation, and no way amenable to the will. He had for some time been under the care of local conjurers, who, failing to relieve by their incantations, demanded a great powpow that should embrace the most noted of the fraternity; they assumed that their failure was due to insufficient *power*, since a half-dozen or more of malevolent spirits were implicated in the production of the malady.

The poor fellow was finally introduced into our midst, when he was submitted to a searching cross-examination as to forgotten or unfulfilled vows; then, after a few uneventful preliminaries, such as looking into amulets in order to determine the number and character of the demons involved, he was placed in the center of the circle of conjurers who had thus ranged themselves to the left of the fire.

Pou-ni-ka-ma-ta, the "Medicine Elk," he of the antlered head, led the jig, circling round and round the invalid, followed by the entire conjuring crew in single file chanting a refrain that ever ended with a line indicative of the unity of purpose and power of the Supreme Manitou on earth, giving a peculiar inflection and intonation to the final word. This was repeated over and over and over again, with unvarying monotony, only to be replaced after a measured period by another higher in key, and more emphatic in enunciation and movement; and

* "Medicine," in its savage sense, admits of no change in orthography, whether used in the singular or plural, or as a verb, adverb, noun, or adjective.

this in turn gave way to a third that embodied still more prominently the peculiarities of the last. During all this marching the performers, each and severally, at varied intervals, cast into the blaze articles taken from their "medicine-bags" or amulet-pouches, offerings that consisted for the most part, as our olfactories afforded abundant evidence, of shreds of skins, bits of bone, horn, hair, and other animal matters, selected without regard to uniformity, but in accordance with the taste or fancy of the individual through some act or incident that was supposed to imbue the same with "medicine."

Turn and turn about these chants were repeated to a running accompaniment of drums, rattles, and bells in the hands of the acolytes or apprentices seated at the opposite side of the fire for the purpose, and who varied their music in accordance with the rise and fall of the voices of their superiors, now and again instituting foul scents on their own account, or chorusing the din with responsive shrieks and howls.

In this way the powwow was carried on for an hour or more, when the entire chorus came to an abrupt stand, and with a final flourish of instruments face inward toward the sufferer. With another flourish each stretched forth his right arm, the hand holding the sacred medicine-bag, which was directed point-blank at the object of conjuration, a position that was maintained so long that it caused my arm to ache through sympathy. And then the leader uttered a sharp and authoritative "*Hugh!—begone!*" when march and tune were resumed as before.

Three times these ceremonies were gone over in all detail, and three times the obnoxious spirits were bidden to depart. Then, in response to queries propounded by *Pou-ni-ka-ma-ta*, the sufferer admitted some little benefit—that sensation was in some measure restored, or, as he expressed it, the arm felt as if awakening from a "big sleep."

Simultaneously with the expiration of the ninth series of ceremonials and the final "Begone!" the poor paralytic became animated by a species of ecstasy, as it were, and sprang into the air several times in rapid succession, whirling the maimed member around his head violently with apparently perfect command, at the same time uttering blood-curdling yells and screeches: then fell to dancing violently to music of his own improvising, more remarkable for volume and pitch than for harmony or sentiment; conducting himself for all the world as if possessed by an infinite number of those gentry that, in Scriptural times, were accredited with an unusual and somewhat precarious fondness for pork.

No one interfered. Indeed, all appeared to regard the matter as one of course. And when the poor crazed paralytic sank to the ground exhausted and helpless, frothing at the lips and every muscle tense and spasmodically twitching and quivering, not a hand was lifted for his resuscitation; after a few moments' gazing, audience and performers

dispersed, while the friends of the unfortunate merely lifted and carried him to his lodge, and there left him alone, to recover or die as the case might be. Justice compels me to add, however, that this apparent stoicism was not so much the result of indifference as of the fact that the man was esteemed "medicine," and hence should not be meddled with; any interference might not only be fatal to the spell that had been worked, but would jeopard the welfare of the individual, bringing the wrath of the spirits upon his own head! *

I visited the subject of conjuration the day following, and found him up, "clothed and in his right mind." Accepting an invitation to a seat beside him, conversation soon turned on the events of the night before, when he assured me, and I presume truthfully, that he had no remembrance of what had occurred subsequent to the moment he announced the partial restoration of sensation, until in the gray of the morning, when he awoke to find himself reclining on the skins in his own lodge. I also availed myself of the opportunity offered for investigation, when I found, much to my amazement, that, save for a slightly atrophied condition of the diseased side, the two halves of the body were coequal in sensation and control. He was confident that permanent relief had been obtained, which I was by no means willing to concede, though I kept my opinions strictly to myself. Subsequently my diagnosis and prognosis were confirmed by a return of the malady, which became even more assertive than before: for now the leg, which before had been in a degree amenable to the will, became perfectly unmanageable, and even the muscles of the face were rigidly set. When I left the neighborhood, a second powwow was proposed, to be conducted on a still grander scale; but I have no means of knowing more of the case or its subsequent treatment. There were, however, reasons convincing to any qualified medical man why there should be no permanent change save for the worse: the case was simply incurable.

One conjurer, whom I knew intimately, and whose adopted brother I was, surpassed by far the most able and expert of the civilized exponents of necromancy. *Wa-ah-poos*, or "The Rabbit," as he was mellifluously known, would perform the most difficult and astounding feats at an instant's notice, regardless of preparation or surroundings. He would allow himself to be bound hand and foot with rawhide thongs, even the whole body enveloped, pinioning the arms and hands to back and sides, yet the very instant a blanket or robe was cast over him he would bound to his feet free, with the bonds gathered in his hands, with the fastenings thereof intact. Once I bound his naked form with powerful strips of green moose-hide, drawing them so tightly that the blood threatened to burst from the ridges of unimprisoned flesh; but it made not the least difference so far as I could discover. On another occasion, in the middle of the day, he was even more elaborately pin-

* Mark the analogy to the demonology of the early Christian era and of the New Testament.

ioned—wound and rewound until he appeared an improvised mummy —employing knots and turns innumerable, such as had been suggested by naval experience; and he passed from my hands only to be lifted into a small tent or "medicine-lodge" erected for the purpose in the midst of an open prairie, which was devoid of all furnishings save a rattle and drum suspended from the interlocking poles at the apex. Scarcely was he concealed from view, however, when both instruments began a low accompaniment to a chant he sang, and the air all about became vocal with a multitude of noises and sounds, some high overhead, some apparently far away, and others in the grass at our feet; and these sounds were not heard singly and in succession, but altogether in one chorus: bisons bellowed, bears growled, wolves howled, wapiti stags roared, frogs croaked, deer stamped and whistled, horses neighed and galloped, dogs and foxes barked, serpents rattled and hissed, squirrels and hares squealed and rustled, the cat tribe spat and swore, and even wild-fowl flapped their wings and uttered their accustomed cries—a feat of ventriloquism, if ventriloquism it was, and I can assign no other cause, unparalleled in all my experience. When the uproar subsided, *Wa-ah-poos* appeared at the entrance of the tent unbound; but the thongs, for which most thorough and diligent search was made, were missing. Calling to him an Iroquois, an utter stranger to all but myself, who had arrived but the day before from beyond the Great Lakes in the province of Ontario, he directed him to a certain tree he pointed out growing on a bluff more than a mile away, bidding him bring what would there be found suspended from a designated branch. The latter, much to the general amazement, returned with the bonds apparently intact; and were I not assured of the impossibility of transporting them to that distance, I should have had no hesitancy in making affidavit that they were those with which the conjurer had been bound, so exactly did every turn and knot appear to be my very own.

A few days later, the same wizard, while conjuring a squaw in the final stage of phthisis (consumption), suddenly thrust his hands beneath the blanket that covered her emaciated form, and dragged forth the carcass of a full-grown gray wolf, which he flung outside into the midst of assembled relatives and friends, by whom it was quickly pounded and trampled into an almost unrecognizable pulp. "The Rabbit" now announced the recovery of the woman as assured. In making this assertion, however, he was "a trifle out," since she died the same night! I had warned him of the probable result, but he responded that it "mattered little." It evidently was not his first experience of the kind, and he found ready excuse in another spirit, a near relative of the first, who had returned unexpectedly from a long journey, and whose presence consequently could not have been foreseen, who took advantage of his (*Wa-ah-poos's*) temporary absence to work its foul purpose!

How the old rogue managed to duplicate the bonds so cleverly and place them in the tree before a knot had been placed in the original, is a problem I leave others to solve, though to my mind it is not so difficult as might be imagined. But how or where he obtained his dead wolf is entirely beyond my conjecture. There was no wolf beneath the blanket five minutes before it came to light, for I had but just given the sufferer a careful examination, and could not have failed to detect its presence. There was but one other occupant of the lodge besides the patient and ourselves—the husband—and he sat too far away for collusion. He had not moved for more than an hour, and no one had passed in or out for double that period of time. The violence of the conjurer's exertions had reduced his apparel until it rivaled that of the historic Georgia major; and a breech-clout and medicine-bag would scarce account for anything larger than a small rodent. There was no available place of concealment: then where *did* it come from?

Subsequently I questioned *Wa-ah-poos* upon the subject, but he would give me no other satisfaction than might be derived from a series of baboonish chuckles and grins, and a repetition of the words, "Medicine—big medicine!"

THE ANTARCTIC OCEAN.

By JOSEPH F. JAMES.

THE Antarctic Ocean occupies a position around the south pole similar to that of the Arctic Ocean at the opposite end of the earth. It fills all the space to the south of the Antarctic Circle. It differs vastly, however, from its northern homologue, for, instead of having land at its outer circumference, it has water. While the North American, the European, and the Asiatic coasts encircle the Northern Ocean, the Pacific, the Atlantic, and the Indian Oceans mingle their waters with those of the frozen zone at the south.

As it differs in physical conditions, so also it differs in having received much less attention from the world at large. While the aim of innumerable expeditions for the past four hundred years has been to find a northwest passage to Asia, to plant a flag at latitude 90°, or to rescue some unfortunate commander and his crew from a horrible fate, and while thousands of dollars have been expended, and hundreds of lives have been lost, there is a strange contrast offered when we turn to the far south. The expeditions which have been sent out by the great nations of the world to explore the vast watery expanse about the southern pole are so few as to be counted on the fingers of one hand, and all the ships which have left records of any extensive explorations beyond the Antarctic Circle might be counted on the fingers of two hands. And yet "within the periphery of the Antarctic

Circle," says Lieutenant Maury, "is included an area equal in extent to one sixth of the entire land-surface of our planet. Most of this immense area is as unknown to the inhabitants of the earth as the interior of one of Jupiter's satellites. . . . For the last two hundred years the Arctic Ocean has been a theatre of exploration; but, as for the Antarctic, no expedition has attempted to make any persistent exploration, or even to winter there." It is noteworthy, too, that in the voyages which have been made not a ship nor a life has been lost south of the circle. "It does not appear," says one writer, "that Antarctic voyages would be attended with any excessive degree of danger. . . . It may even be found that the Antarctic barriers are impenetrable; but this has certainly not as yet been demonstrated."

In consequence of this limited exploration, comparatively little is known of the physical condition of this part of the globe. It has been conjectured that a vast continent exist in it. But, if it is there, only mere outlying parts of it have been seen, and those that are known are of such a character as to preclude their being of any value to the world. "Consider for a moment," says Captain Hogg, in his account of the second voyage of Captain Cook, "what thick fogs, snows, storms, intense cold, and everything dangerous to navigation, must be encountered by every hardy adventurer; behold the horrid aspect of a country impenetrable by the animating heat of the sun's rays; a country doomed to be immersed in everlasting snow! See the islands and floats on the coast, and the continual falls of the ice-cliffs in the ports; these difficulties, which might be heightened by others not less dangerous, are sufficient to deter any one from the rash attempt of proceeding farther to the south than our expert and brave commander has done, in search of unknown countries, which, when discovered, will answer no valuable purpose whatever."

The discoveries of Gheritk, Cook, Weddell, Bisco, D'Urville, Wilkes, and Ross—and, if to these we add the Challenger Expedition, we have the whole number of explorers—have revealed the existence of a certain amount of land within the Antarctic Circle. In the year 1600 Theodoric de Gheritk was driven during a gale as far as 64° south latitude, and reported land in that neighborhood. In his second voyage, Captain Cook penetrated during the summer seasons of 1773–'75 to 71° south without finding land previously reported in certain districts; yet he, as well as most of the earlier geographers and navigators, believed firmly in the existence of a southern continent, of little use, as he supposed it to be, for "the ice that is spread over this vast Southern Ocean must originate," in Cook's opinion, "in a track [tract] of land . . . which lies near the pole, and extends farthest to the north opposite the South Atlantic and Indian Oceans; for, ice being found in these farther to the north than anywhere else, . . . land of considerable extent must exist near the south."

This land was largely conjectural until the expeditions sent out by

the French, American, and English Governments under D'Urville, Wilkes, and Ross, respectively, between the years 1838 and 1840. D'Urville left the Strait of Magellan in January, 1838, with two vessels. He penetrated with great difficulty the ice-fields which surround the pole, and reported land as lying about two hundred miles south of the Orkney Islands. The next year he attempted to explore from an opposite quarter, and reported a further discovery which he called Adelia's Land. It seems probable that most of his discoveries were only huge cliffs of ice, though he is said to have landed on a little islet off the coast in one place, and carried away quartz and gneiss rocks torn from the cliffs. He coasted along the ice-cliffs for a distance of more than one hundred miles, and thus describes their appearance:

"The walls of these blocks of ice far exceeded our masts and rigging in height; they overhung our ships, whose dimensions seemed ridiculously curtailed. We seemed to be traversing the narrow streets of some city of giants. At the foot of these gigantic mountains we perceived vast caverns hollowed by the waves, which were there ingulfed with a crashing tumult. The sun darted his oblique rays upon the immense walls of ice, making them look as if they were crystal, and presenting effects of light and shade truly magical and startling. From the summit of these mountains numerous brooks, fed by the melting ice produced by the summer heat of a January sun in these regions, threw themselves in cascades into the icy sea. Occasionally these icebergs would approach each other so as to conceal the land entirely, and we could only perceive two walls of threatening ice whose sonorous echoes sent back the word of command of the officers. The corvette which followed the Astrolabe appeared so small, and its masts so slender, that the ship's crew were seized with terror. For nearly an hour we only saw vertical walls of ice."

Wilkes, as the commander of the American expedition, charted lands which subsequent navigators failed to find. The Challenger sought in vain for what he named Termination Land, but could find only open sea. He explored the ocean for a distance of fifteen hundred miles east and west, skirting a barrier of ice often one hundred and fifty feet or more in height, and sometimes extending in an unbroken line for fifty miles.

Lastly, Sir James Ross, the commander of the English expedition, penetrated from an opposite quarter to Wilkes, and in the same year, and succeeded in reaching latitude 78°, the highest before or since attained. He found a continent which he called Victoria Land, and he describes its first appearance as follows: "On January 11, 1841, in about latitude 71° south and longitude 171° east, the Antarctic Continent was first seen, the general outline of which at once indicated its volcanic character, rising steeply from the ocean in a stupendous mountain-range, peak above peak enveloped in perpetual snow, and clustered together in countless groups resembling a vast mass of crys-

tallization, which, as the sun's rays were reflected on it, exhibited a scene of such unequaled magnificence and splendor as would baffle all language to portray, or give the faintest conception of. One very remarkable peak, in shape like a huge crystal of quartz, rose to the height of 7,867 feet, another to 9,096, and a third to 8,444 feet above the level of the sea. From these peaks ridges descended to the coast, terminating in bold capes and promontories. . . . On the 28th, in latitude 77° 31′ and longitude 167° 1′, the burning volcano, Mount Erebus, was discovered, covered with ice and snow from its base to its summit, from which a dense column of black smoke towered high above the other numerous lofty cones and crateriferous peaks with which this extraordinary land is studded from the seventy-third to the seventy-eighth degree of latitude. Its height above the sea is 12,367 feet, and Mount Terror, an extinct crater, near to it, . . . attains an altitude little inferior, being 10,884 feet in height, and ending in a cape, from which a vast barrier of ice extended in an easterly direction, checking all further progress south. This continuous perpendicular wall of ice, varying in height from two hundred to one hundred feet, its summit presenting an almost unvarying level outline, we traced for three hundred miles, when the pack-ice obstructed all further progress."*

From 1841 up to 1874 when the Challenger visited the Antarctic Circle, no vessel has spent any lengthy period in this region; so, having thus reviewed the discoveries of the various explorers, let us turn to that element which is so much more abundant than land, the water, and examine its form in a solid state. The icy barrier of which we hear so much is thus described by Sir James Ross: "As we approached the land, . . . we perceived a low white line extending from its extreme eastern point as far as the eye could perceive to the eastward. It presented an extraordinary appearance, gradually increasing in height as we got nearer to it, and proving at length to be a perpendicular cliff of ice between 150 and 200 feet above the level of the sea, perfectly flat and level at the top, and without any fissures or promontories on its even seaward face." This barrier extended for a distance of 450 miles, and nowhere was there any opening of consequence by which it could be penetrated.

Where such immense quantities of solid ice exist, there are icebergs in abundance. The ones floating in these seas are of enormous size, and present a vastly different appearance from those seen at the north. There they are commonly jagged and sharp-pointed from their first leaving the parent glacier, afterward assuming all sorts of weird shapes. But at the south they are at first, and for a long while afterward, flat-topped, with square-cut sides, and with a stratified structure. The top stratum is from ten to twelve inches thick. The thickness of the strata gradually decreases toward the bottom, and at the

* Quoted in Somerville's "Physical Geography," London, I, pp. 282–284.

level of the water is not more than two inches. A line of clear, blue ice marks the boundary of each layer, produced, in the opinion of various writers, by the melting of the top portion of the snow-fall of a previous winter, while the white part represents the unmelted part of the snow-fall. Wilkes estimates the snow-fall in this region at thirty feet in the year, and, as only a very small part of this can be melted in the course of the short summer, an immense accumulation must go on. The small part of each year's fall that is melted will be clear ice, and this is represented by the line of blue in the berg; so that, by counting the number of layers in a berg, some idea can be had of its age.

Sir Wyville Thomson says that the reduction in thickness of the layers from top to bottom is due mostly to compression, and estimates that at a depth of 1,400 feet enough heat will be generated to melt the ice. On the other hand, Croll contends that the temperature of the bottom of the immense icebergs, which sometimes tower 700 and 1,000 feet above the water, is 20° or 22° Fahr., and when we remember that ice floats with from six to seven times its height below water, and that the bottom of a 1,000-foot berg would be 6,000 or 7,000 feet below the surface, it is easily seen that no melting would occur on the bottom of an ice-sheet only 1,400 feet thick. The reason assigned by Croll for the gradual thinning of the ice-layers toward the bottom is, that, instead of being due solely to compression, it is due mainly to what he terms dispersion. In other words, if, at 85° south, a mass of ice covers one square foot of surface, it will, in its gradual passage north, be made to cover two square feet at 80° latitude; at 70° it will occupy four square feet, and, at 60° south, six square feet; that is to say, a stratum which was one foot thick in 85° latitude will be only two inches thick when it has reached 60° latitude.

The discharge of icebergs from the extremity of the ice-field takes place constantly, and they are sometimes huge. Croll has collected notices of bergs which towered 400, 580, 720, 960, and 1,000 feet above the sea-level, and, as six or seven times the bulk above water floats below, some adequate idea can be formed of the contents of a berg three, four, or five miles in length. As the ice-field must have an onward motion to cause this discharge, it has been calculated that one foot in 211 is the smallest slope which will be effectual, and that the ice moves here at the rate of about one quarter of a mile per annum. As it is impossible that thirty or forty feet of snow can be melted in a single short summer's season, it follows that there must be a rapid accumulation all the time. This accumulation will probably be greatest at the pole, and Croll estimates that here the ice has attained a thickness of about seven miles. Allowing this estimate to be correct, and it does not seem excessive, when it is remembered that the thickness of the ice-sheet over Northern New England, during the Glacial period, was 6,000 feet, the question arises. Upon what sort

of land is this immense mass of ice piled? It is a question not easy to answer definitely, because no one has ever seen it. The idea has generally been that the continent is high land. But it has been urged with justness that, had the glaciers descended from a mountainous country, they would bear upon their surfaces, or in their mass, stones to indicate the sort of rock of which the mountains were made. But such is not the case. It is said that stones are never found on the Antarctic bergs, and Captain Cook states expressly his idea that the bergs are formed at the mouths of rivers or cataracts, "because we never found any of the ice which we took up in the least incorporated or connected with earth." He goes on to say: "The ice-islands . . . must be formed from snow and sleet consolidated, which gather by degrees, and are drifted from the mountains. In the winter, the seas or the ice-cliffs must fill up the bays if they are ever so large. The fall of snow occasions the accumulation of these cliffs, till they can support their weight no longer, and large pieces break off from these ice-islands. We are inclined to believe that these ice-cliffs, where they are sheltered from the violence of the winds, extend a great way into the sea."

The discovery, by Sir James Ross, of the Parry Mountains and Mounts Erebus and Terror, in latitude 78°, tended to confirm the prevailing notion of a high and mountainous land forming the Antarctic Continent. But the Parry Mountains are merely conjectural, having been seen only at a distance, and it is well known that the coasts charted by some navigators have been proved by subsequent ones to have been either clouds merely or else islands of ice. The most recent idea is, that the land about the pole consists of a cluster of low islands, rising but little above the sea-level, but united by masses of ice. The gradual accumulation of snow for centuries has raised a cap, as before stated, seven miles thick, and from this cap the ice flows away in all directions, forced onward by the pressure of the enormous mass behind.

The immense size of the icebergs seen in the Antarctic Ocean is without a parallel elsewhere. Croll in a late essay gives a list of the largest of which there is record, and we find they range from 400 to 1,000 feet above the water. The one 1,000 feet high was observed in latitude 37° 32′ south, and was nearly five miles long. When these bergs are first broken off and float away they all have the tabular form, but, as they grow old and drift northward into warmer airs and waters, they become fissured and seamed in all directions; pinnacles and domes and caverns appear, and they become beautiful objects. Wilkes describes one as exhibiting "lofty arches of many-colored tints, leading into deep caverns open to the swell of the sea, which, rushing in, produced loud and distant thunderings. . . . Every noise on board, even our own voices, reverberated from the massive and pure white walls. These tabular bergs are like masses of beautiful ala-

baster. . . . If an immense city of ruined alabaster palaces can be imagined, of every variety of shape and tint, and composed of huge piles of buildings grouped together, with long lanes or streets winding irregularly through them, some faint idea may be formed of the beauty and grandeur of the spectacle."

Dredging and trawling in the Antarctic Ocean have not been extensive. The Challenger Expedition penetrated to 66° south latitude, and dredged and sounded frequently. The temperature of the surface-water ranged from 29·5° to 34·5°, while at 200 fathoms it varied from 30° to 35·5°. Wherever the dredge or trawl was used, quantities of stones, rounded and polished, of basalt and other rocks, were brought to the surface, dropped to the sea-bottom, presumably by icebergs. Life is not abundant, but what exists seems related to that of the northern ocean. Ross, in 1840, dredged in 1,620 feet in latitude 73°, and found several forms of life, of which he says: "It was interesting among these creatures to recognize several that I had been in the habit of taking in equally high northern latitudes; and, although contrary to the general belief of naturalists" (quite modified in the past ten years, however), "I have no doubt that, from however great a depth we may be able to bring up the mud and stones of the bed of the ocean, we shall find them teeming with animal life; the extreme pressure at the greatest depths does not appear to affect these creatures. Hitherto we have not been able to determine this point beyond a thousand fathoms, but from that depth several shell-fish have been brought up with the mud" (volume i, page 202).

SOME ECONOMICS OF NATURE.

By Dr. ANDREW WILSON.

AMONG the views of living Nature, and indeed of the inorganic universe as well, which receive tacit acceptance and sanction from ordinary thinkers, there are certain phases deemed incontrovertible in their plain, every-day demonstration. Before our eyes, for instance, we see *Madre Natura* spending her wherewithal in apparent thriftlessness and woful waste. The proverb, "Waste not, want not," so thoroughly and repeatedly dinned into youthful ears, would seem to have no application to the works and ways of the prodigal All-mother that surrounds and encompasses us. The flower that "blooms unseen and wastes its sweetness on the desert air" is a very mild illustration of a nature-spirit which appeals in more forcible ways to the mind as an example of needless contrivance, wasted effort, and useless prodigality. We fly to Tennyson for that apt quotation concerning the fifty seeds produced, and whereof only one comes to the full fruition of its race. Every summer day shows us how true apparently the

poetic axiom holds. Every spring-time seems to teach us the same truism. The pines and other cone-bearing trees discharge their pollen or fertilizing matter in clouds. The winds, as Nature intends, sweep this pollen from their branches, on the "flowers" of which it has been produced. Carried through the air for miles, so much of the pollen-cloud will fall on the receptive "cones," fertilize the ovules, and thus convert them into seeds, whence a new dynasty of trees may arise. But countless showers of pollen are spent in vain, irrecoverably lost, and sent abroad to no purpose whatever. They fall on barren ground; they litter the earth miles away from their parent trees, or cover the surface of lakes for miles with a yellow film—their purpose futile and their production vain. True it is, as the botanist will tell us, that more pollen must be produced in the case of wind-fertilized plants than is found in that of insect-impregnated flowers. It is a case of "hit or miss" with the wind-fertilized trees, while it is an illustration of an exact calculated aim with the flowers. Hence Nature has to provide for the contingency which awaits her efforts in the former instance by providing a very copious supply of pollen. She is in the position here, not of the marksman who takes deliberate aim at the bull's-eye with his rifle and single bullet. Contrariwise, she uses her Gatling gun or her mitrailleuse in the act of fertilizing the trees. She showers her bullets at the object in the hope that some of them will hit, and with the equally plain expectation that many must miss altogether. The whole process appears to be wasteful in the extreme, natural affairs notwithstanding, and the Tennysonian couplet is practically realized when the spectacle of tons of wasted pollen is beheld, discharged as these are at the mercy of any wind that blows, and sent into the air to accomplish hap-hazard what in other plants is often effected by deliberate and carefully calculated mechanism.

The notion that Nature possesses any system of economics at all might well be questioned by the observer who discerns the apparent waste through which many natural works and ways are carried out. But here, as in the case of so many other phases of life, the two sides of the medal must be carefully studied. It is not the case that Nature is uniformly neglectful of her resources, any more than it is correct to say that she is always saving or perennially economical. Circumstances alter cases in the phases of natural things as in human affairs, and we may readily enough discover that in several instances a very high degree of well-calculated prudence and foresight, speaking in ordinary terms, is exercised in the regulation of the universe of living and non-living things alike.

Take, as a broad example of the close adjustment of ways and means to appointed ends, the relationship between animals and green plants in the matter of their gaseous food. That the animal form demands for its due sustenance a supply of oxygen gas is, of course, a primary fact of elementary science. Without oxygen, animal life

comes to an end. This gas is a necessary part of the animal dietary. It supplies the tinder which kindles life's fuel into a vital blaze, and in other ways it assists not only the building-up but the physiological "breakdown" of the animal frame. Part of this "breakdown" or natural waste accompanying all work, like the inevitable shadow, consists of carbonic-acid gas. This latter compound is made up of so much carbon and so much oxygen. It arises from the union of these two elements within the body, and is a result of the production of heat, representing, in this way, part of the ashes of the bodily fire. Viewed as an excretion, as a something to be got rid of, and as a deadly enough element in the animal domain, this carbonic acid is a thorough enemy of animal life. It is not only useless in, but hurtful to, the animal processes. Ventilation is intended as a practical warfare against the carbonic acid we have exhaled from lungs and skin; and "the breath, rebreathed," is known to be a source of danger and disease to the animal populations of our globe. Here, however, the system of natural economics appears to step in and to solve in an adequate fashion this question of carbonic acid and its uses. Just as the chemist elaborates his coal-tar colors from the refuse and formerly despised waste products of the gas-works, so Dame Nature contrives a use for the waste carbonic acid of the animal world. She introduces the green plants on the scene as her helpmates and allies in the economical work. Every green leaf we see is essentially a devourer of carbonic-acid gas from the atmosphere. That which the animal gives out, the green plant takes in. Not so your mushrooms and other grovelers of the vegetable kingdom, which, having no green about them, refuse to accept the cast-off products of the animal series, and despise the carbonic acid as a poor but proud relation discards the gift of our old garments. The green plant is the recipient of the animal waste. The leaves drink in the carbonic acid which has been exhaled into the atmosphere by the tribes of animals. They receive it into their microscopic cells, each of which, with its living protoplasm and its *chlorophyl* or green granules, is really a little chemical laboratory devoted to the utilization of waste products. Therein, the carbonic-acid gas is received; therein, it is dexterously split up, "decomposed," as chemists would have it, into its original elements, carbon and oxygen; and therein is the carbon retained as part of the food of the plant, while the oxygen, liberated from its carbon bonds, is allowed to escape back into the atmosphere, to become once again useful for the purposes of animal life.

There would thus appear to be a continual interchange taking place between the animal and plant worlds—a perpetual utilization by the latter of the waste products of the former. It is immaterial to this main point in natural economics that the reception of carbonic acid by green plants can only proceed in the presence of light. It is equally immaterial that by night these green plants become like ani-

mals, and receive oxygen (an action which, by the way, they also exhibit by day), and emit carbonic acid. These facts do not affect the main point at issue, which is the direct use by the plant of animal waste, and a very pretty cycle of operations would thus appear to have been established when botanical research showed the interactions to which we have just alluded.

Going a step further in the same direction, we may find that this utilization of animal waste is by no means limited to the mere reception and decomposition of carbonic-acid gas by green plants. It may be shown that the economical routine of Nature is illustrated in other phases of the common life of the world. The general food of plants is really animal waste. We fructify our fields and gardens with the excretions of the animal world. The ammonia which plants demand for food is supplied by the decay of living material, largely animal in its nature; and even the sordid fungi flourish amid decay, and use up in the system of natural economy many products for which it would be hard or impossible to find any other use. What we, in ordinary language, term "putrefaction" or "decay," is really a process of extermination of the decomposing matter. No sooner does an organism —animal or plant—part with vitality and become as the "senseless clod," than thousands of minute organisms—the "germs" of popular science—make it their habitation and their home. The process of putrefaction, unsavory as it may be, is really Nature's way of picking the once living body to pieces, of disposing of it in the most economical way. So much of it is converted into gas, which, mingling with the air, feeds the green plants as we have noted. So much of the dead frame is slowly rendered into nothingness by the attack of the microscopic plants which are the causes of decomposition. Nature says to these lower organisms: "There is your food. In nourishing yourselves, accomplish my further work of ridding the earth of yon dead material." And so much, lastly, of the once living frame—assuming it to have been that of the higher animal—as is of mineral nature, and therefore resists mere decay, will in due time be dissolved away by the rains and moisture, and be carried into the soil, to enter into new and varied combinations in the shape of the minerals which go to feed plants. Shakespeare must surely have possessed some inkling of such a round of natural economics when we find him saying:

> "Imperial Cæsar, dead and turned to clay,
> Might stop a hole to keep the wind away:
> Oh, that that earth, which kept the world in awe,
> Should patch a wall t'expel the winter's flaw!"

Continuing the study, we may see yet further glimpses of the great system of general regulation which guards Nature from overdrawing her accounts in connection with the arrangement of living things. Not only in beings of high degree, but in animals of low estate, do we meet with illustrations of the economy of power and the

saving of needless expenditure of force and energy which Dame Nature practices. The study of human anatomy, which of course is one in many points with the comparative science as applied to lower life, reveals not a few instructive examples of this saving tendency in life's ways. The human head, for example, is nicely balanced on the spine. Compared with heads of lower type, this equipoise forms a prominent feature of man's estate. The head-mass of dog, horse, or elephant requires to be tied on, as it were, to the spine. Ligaments and muscular arrangements of complex nature perform their part in securing that the front extremity of these forms should be safely adjusted. But in man there is an absence of effort apparent in Nature's ways of securing the desired end. The erect posture, too, is adjusted and arranged for on principles of neat economy. The type of body is the same as in lower life. Humanity appears before us as a modification, an evolution, but in no sense a new creation. Man rises from his "fore-legs"—arms being identical, be it remarked, with the anterior pair of limbs in lower life—and speedily there ensues an adaptation of means to ends, and all in the direction of the economical conversion of the lower to the higher type of being. The head becomes balanced, and not secured, as we have seen, and thus a saving of muscular power is entailed. Adjustments of bones and joints take place, and the muscles of one aspect, say the front, of the body, counterbalance the action of those of the other aspect, the back; and between the two diverging tendencies the erect position is maintained practically without effort. So, also, in the petty details of the work, Nature has not been unmindful of her "saving clause." We see this latter fact illustrated in the disposition of the arrangements of foot and heel. One may legitimately announce that man owes much to his head; but the truth is he owes a great deal of his mental comfort and physical economy to his heels. The heel-bone has become especially prominent in man when compared with lower forms of quadruped life. It projects far behind the mass of foot and leg, and thus forms a stable fulcrum or support, whereon the body may rest. Here, again, economy of ways and means is illustrated. There is no needless strain or active muscular work involved in the maintenance of the erect posture in man. It is largely a matter of equipoise, wrought out through a scheme of adaptation which takes saving of power and energy as its central idea.

Physiological research lays bare many other points in human and allied life which bear out the contention and principle that natural economics is a powerful and prevailing reality of life. Muscles are ordered, for example, on the plain principle of single acts and of divided tasks. Thus a man bends his forearm on the upper arm largely by aid of the familiar "biceps." This done, the "biceps" retires from the field of work. The arm is straightened by the action of a different muscle, the "triceps." So, also, with the shutting and open-

ing of the hand. While the "flexors" of the fingers placed on the front palm or surface of the limb close the hand, it is the "extensors" of the opposite aspect of the forearm (whose sinews we see in the back of the hand), which open or extend our digits. There may be multiplication of organs here, it is true; but, given the original power to produce them, there is a clear economy of vital wear and tear exercised in the avoidance of too onerous tasks being laid upon any one muscle.

It is something of this principle which we find reflected also in the circulation of the blood. Here we see the heart's left ventricle (or larger cavity of the left side) driving blood, as does a force-pump, out into the great system of arteries, which everywhere throughout the body carry the nutrient stream. No sooner, however, has the blood-stream, impelled by the contraction of the muscular walls of the heart's ventricle, passed into the great main artery (the aorta) which arises from the heart, than an economical principle of an important kind comes into play. This principle is represented by the elasticity of the arteries which bear the blood to the body. They possess a circular coating of muscle which diminishes in thickness as the vessels grow smaller and smaller, and are therefore removed from the influence of the pumping-engine of the circulation. The arterial coating is itself elastic, and the whole system of these vessels is thus endowed with a high amount of resiliency. Their internal coats are smooth and shining, as also is the lining of the heart's cavities, friction being thus reduced to its minimum. The united sectional area of the branches of the dividing artery is larger than the same area of its stem, so that the collective capacity of the vessels increases markedly as we pass from the heart outward to the minuter channels of the circulation.

The blood is thus driven through an elastic set of tubes presenting the least possible resistance to the flow of fluid through them, and economy of power is thus again witnessed in the details of the human estate. Nor is this all. That there exists resistance to the flow of blood is, of course, a necessary condition in any system wherein large tubes or arteries branch out into small tubes (the capillaries), and these, again, unite to form larger or return vessels—the veins. The problem of living Nature would here appear to resolve itself into the inquiry, how the apparently intermittent, or spasmodic, work of the heart may be converted into a constant and continuous action.

If we suppose that a pump drives water through a rigid pipe, we see, in such a case, just as much fluid to issue from the pipe's end as entered it at the stroke of the pump. Practically, also, the escape of the water from the pipe takes place almost simultaneously with its entrance therein. If we place some obstacle or resistance to the free flow through the pipe, while the pump acts as before, the quantity of water expelled will be less, because less fluid enters the pipe. Just as

much water will leave the tube as enters it under the two conditions of no resistance and of the presence of such obstacle to the flow. If now we substitute for our rigid pipe an elastic one, the resistance to the water-flow is diminished, no doubt, but the fluid will, as before, issue in jets; that is, in an intermittent and not continuous fashion. There is "easy come and easy go" in the elastic tube, as in the rigid one where no resistance exists. The elasticity, in other words, is not called upon to act in modifying the flow because the course of the fluid is clear and open. Suppose, now, that some obstacle or resistance is introduced into the elastic tube. The fluid can not escape so readily as before, and it tends, as a matter of course, to accumulate on the near or pump side of the obstacle. The tube gives, so to speak, and accommodates the water which is forced to wait its turn for exit. Each stroke of the pump, it is true, sends its quantity into the tube, but between the strokes the swollen and expanded tubes, in virtue of their elasticity, act as an aid to the pump, and by exercising their power force the accumulated fluid past the point of resistance. There is rest in the rigid tube between the pump-strokes. There is, contrariwise, activity in the elastic tube, due to the overcoming by its elasticity of the obstacle to the flow, and to its work of keeping the fluid moving and of avoiding distention and blockage. It is possible, moreover, to conceive of the elastic reaction of the tube being so great that the accumulated fluid will be made to pass the knotty point before the next stroke of the pump occurs. Let us imagine, lastly, that the strokes succeed one another in rapid succession, and that the elasticity of the tube is powerful enough to overcome the resistance opposing the flow of fluid, and we shall arrive at a state of matters wherein not only will the obstacle become practically non-existent while as much fluid leaves the tube as enters it, but the flow from the far end of the tube will also be converted into a continuous and stable stream.

This latter condition of matters is exactly reproduced in the circulation of the blood. There is great resistance found on the arterial side of the heart. Each impulse has to send blood into a vessel which is elastic in itself, as we have seen; but immediately on the first stroke of the heart succeeds a second. Hence the blood accumulates on the heart's side before that propelled by the first stroke has been completely disposed of. Distention and strain of the vessel succeed, and one of two results must follow. Either the circulating arrangements must collapse, or the elasticity of the tubes into which the blood is being perpetually forced will acquire power sufficient to overcome the resistance, and to propel onward the amount of blood with which each stroke of the heart charges the circulation. Here the true meaning of the rapid work of the heart and of the elasticity of the arteries becomes apparent. The otherwise intermittent flow of blood is converted into a continuous stream. The heart keeps the arteries overdistended on the near side of the resistance, while these elastic tubes,

so treated, discharge themselves in turn onward, and at a rate which corresponds to that with which the force-pump action of the heart charges them from behind. And so, tracing the hydraulics of the circulation through its phases we see, firstly, the heart over-distending the elastic arteries. We witness the arteries emptying themselves into their minute continuations, the capillaries, and through these latter into the veins or return-vessels. The economy is witnessed here in the easy means adapted for converting without complications a spasmodic flow of blood into a continuous stream; insuring also that the amount of of blood which flows from the arteries to the veins during the heart's stroke and pause exactly equals that which enters the circulation at each contraction of the ventricle. In other words, the tremendously high pressure of the arteries of our bodies saves at once the multiplication of bodily pumping-engines and conserves the force of the heart itself.

There are other points connected with the circulation, more or less intimately, to which a passing allusion may be made. The low-pressure flow of blood in the veins upward to the heart from the lower parts of the body is thus favored by the high pressure of the arterial system, and natural economy of energy is thus again exemplified. The arteries seem to be intent on the work of getting rid of their contents through the capillaries into the veins. There is no resistance, in fact, to the venous flow which is carried on at low pressure. Again, the ordinary muscular movements of the body are utilized in the economy of life, to favor the return of the venous blood. For the veins are compressed in the muscular movements, and, as they are provided with valves which prevent back-flow, the compression can act in one way only—namely, to aid the upward or backward return of blood to the heart's right side.

The overplus of the blood is known as *lymph*, and is gathered from the tissues by vessels known as *absorbents* or *lymphatics*. These return the lymph to the blood-current for future use. Nature "gathers up the fragments" here as elsewhere, and sees that the lymph or excess of the blood-supply is once more garnered into the vital stream of the circulation. If we ask how this lymph-flow is maintained from all parts of the body toward the great vein in the neck where the lymph joins the blood, we again light upon the question of high pressure in one side of matters and low pressure in the other side. All the ordinary movements of our bodies are economically pressed by Nature into the service of the lymph-flow. As in the veins, the valves of the lymphatics prevent backward movement, and as in the veins the muscles compress the vessels, and common movement thus assists a special end. Even the motions of breathing favor the return of the lymph. For, when we inspire, the pressure in the great veins becomes negative in character, and lymph is thus capable of being sucked into the circulation from the main tube or duct of the lymph-system. When we

"breathe out," the pressure in the large veins increases it is true, but a valve guards the entrance, which in inspiration is free, and untoward consequences are thus prevented. It is a notable fact that in many animals organs known as lymph-hearts are developed. As in the frog, these contractile organs assist the lymph in its return to the circulation. It therefore becomes of interest to note how, in the higher walks of existence, the mechanical contrivances and actions of the body undergo an evolution which not only avoids multiplication of parts and organs, but also conserves and economizes the energy which has to be expended in the maintenance of life.

The function of breathing has been incidentally alluded to in the course of the foregoing remarks, and, in considering the details of this paramount duty of life, we find additional proof of the fact that Nature's economics in higher life are frequently expressed in terms of admirable mechanical contrivance. Primarily, in the case of respiration, we find the bony elements of the chest fitly developed in view of certain physical qualities, of which elasticity forms perhaps the chief. The front wall of the chest is practically composed of cartilage or "gristle." The "costal cartilages," or those of the ribs, intervene between the upper seven ribs and the "sternum" or breast-bone. The eighth, ninth, and tenth pairs of ribs also possess cartilages, but these run into and join the gristly extremity of the seventh pair; while the last two pairs of ribs (eleventh and twelfth) spring from the spine behind, but are not attached in front at all. Essentially, the chest is a bony cage, possessed of high elasticity. Even in the dried skeleton, pressure from above, downward or backward, applied to the front of the chest shows this quality of its structures in a marked fashion.

If we study, even superficially, the mechanism involved in breathing, we may gain an idea of the key-note of the process in so far as economy of force is concerned. "Breathing in," if we reflect upon the nature of the act in our individual persons, is a matter of some trouble. It involves a large amount of labor; it gives us much muscular trouble, so to speak. In the case of a deep inspiration, we exaggerate the effort seen in normal breathing, and we may therefore appreciate still more exactly the expenditure of energy required to carry on this necessary function of vitality. But "breathing out" is a widely different matter. We let the chest "go," as it were, at the close of inspiration, and, without an effort, it returns to its position of rest. We expend force in "breathing in"; we appear to exert none in "breathing out." The former is a muscular act performed by a complex series of muscles, and participated in by the lungs and other structures connected with the chest. The latter is an act which partakes, even to the common understanding, of the nature of a recoil; and in this latter supposition we perceive how economy of labor in the human domain is again subserved.

Breathing, then, means that we enlarge the chest by the action of

certain muscles, that the pressure of air in the lungs becomes reduced as compared with that outside, and that in consequence air rushes into the lungs through the windpipe until an equality of air-pressure inside and outside the lungs is produced. This is the act which is accomplished forcibly, against gravity, and by aid of very considerable muscular power. We are said to perform no less than twenty-one foot-tons of work by means of our respiratory muscles in twenty-four hours —that is to say, the work of these muscles, extending over twenty-four hours' period, if gathered into one huge lift, would raise twenty-one tons weight one foot high.

By a little additional muscular labor we take in a deep breath, still further enlarge the chest, and inhale an additional quantity of air. The great muscle named the diaphragm or "midriff," which forms the floor of the chest, is the chief agent involved in the act of inspiration. It descends, while the ribs are elevated, and, as the chest enlarges, the inflow of air takes place. The lungs themselves are highly elastic bodies. They follow the movements of the chest-walls, and thus expand and contract—they suffer dilatation and compression—as the chest-walls move in the acts of respiration. But, when ordinary "breathing out" is studied, we see that it is as clearly a matter of recoil, as has been stated, as "breathing in" is a matter of exertion. Here elastic reaction steps in to complete the full act of breathing. Nature saves her energies and husbands her strength in this truly physiological division of labor. When we inspire, the lung-substance, elastic in itself, is put on the stretch; the cartilages of ribs and breast-bone are similarly elevated and expanded, and the whole chest is, so to speak, forced into its position of unrest. Then comes the reaction. The muscles of inspiration cease their action; they relax, and the elastic lungs recover themselves and aid in forcing out the air they contain. So, also, when the rib-muscles have come to the end of their tether in elevating these bones, the elastic recoil of the ribs and breast-bone serves to diminish the capacity of the chest, and to further expel the air from within its contained lungs. Labored or excessive breathing, as most readers know, calls into play extra help from muscles not ordinarily used in natural respiration. This fact takes us out of the normal way of life into the consideration of abnormal or diseased states, and demonstrates that the economy of Nature disappears when phases of morbid action fail to be observed. In natural breathing, however, we see conservation once more in the easy recoil which follows the muscular labor of inspiration. The physiology of a sigh and its relief can be readily appreciated on the basis which shows how the easy act of expiration is correlated with the more labored action and duty of enlarging the chest.

A phase of Nature which is by no means foreign to the foregoing illustration of the conservation of power in the human body is presented to us in several aspects of lower life. In the breathing of cer-

tain animal forms, belonging to the *Molluscan* races, we may discover equally admirable examples of economy in natural work. Among the cephalopods or cuttle-fishes we observe such features. Any one who has seen an octopus resting in its tank in an aquarium must have been struck by the puffing and blowing movements of the sack-like body, the nature of which excited Victor Hugo's imaginative powers in the "Toilers of the Sea." The octopus is seen to inspire and expire with great regularity. The soft body expands and contracts rhythmically enough to excite a natural comparison between its respiratory acts and our own. If we could dye the water so that our eye could follow the currents which the octopus inhales and exhales, we should perceive that at each inspiration the soft body expands, and water is drawn in two currents into the neck-openings. These openings lead directly each into a gill-chamber of the animal. Here, inclosed in its own cavity, we find a plume-like gill. In its nature, this structure is simply a mesh-work of blood-vessels, and thus comes to resemble a lung in its essential features. Impure blood—that is, blood laden with the waste materials of the octopus-body, with the products of the vital wear and tear—is driven into the gill on one side. Subjected to the action of the oxygen gas contained in the water breathed in, the blood is purified. Its waste materials are given forth to the water, and it is passed onward out of the gill on its way to the heart for recirculation throughout the cuttle-fish frame.

Breathing in oxygen entangled in the water is, therefore, in the case of the cuttle-fish, an analogous act to that seen in higher animals, which inhale oxygen directly from the air. The octopus, however, performs an expiratory act likewise. Placed below the head is a short tube, named in zoölogical parlance the "funnel." When cuttle-fish inspiration has come to an end, expiration begins. The body contracts, and the water, which a moment before was drawn into the gill-chambers by the neck-openings, is expelled from the "funnel." The openings of entrance are guarded by valves. These close when expiration begins, and the water has no choice save to find a forcible exit by the tube just named. So far, in octopus existence it would seem as though there was no economy of power exhibited in the act of breathing. Muscular action expands the soft body, and muscular force contracts it. There is exhibited here a plain difference between the octopus and the higher vertebrate.

But the story of cuttle-fish economy is not yet completed. A moment more and your octopus, which sat crouched in the bottom of the tank, is seen to wing its way through the water. It skims like a living rocket through the clear medium in which it lives, as if impelled by some marvelous and invisible agency. The secret of this flight is the solution of cuttle-fish economy and reserve force. So long as the resting-mood prevails, the water used in breathing is ejected slowly, or at least without any marked display of force. But when locomo-

tion has to be subserved, and when the cuttle-fish desires to swim, it propels itself through the water by aid of a veritable hydraulic engine. The effete water from the gills is ejected with force from the funnel, and by the reaction of this *jet d'eau* upon the surrounding medium the animal is enabled to execute its aquatic flights. Economy of a very rigid order is illustrated clearly enough in octopod existence. The otherwise useless "breath" of the animal becomes converted into a means of locomotion.

A still closer parallel to the human chest-recoil, perchance, may be found in the case of certain poor relations of the octopus. These lower forms are the mussels, oysters, cockles, clams, and other bivalve shell-fish which frequent our own and other coasts of the world. Incased in its shell, a mussel or oyster, all headless as it is, and possessing in its way a strictly "local habitation," in that it is a fixture of the coast or sea-depth, presents us with the type of an apparently vegetative life. But there is abundant activity illustrated within the mussel or oyster shell. There are millions of minute living threads—the *cilia* of the naturalist—perpetually waving to and fro as they crowd the surface of the gills. These cilia, acting like so many microscopic brooms, draw in the currents of water necessary for food and breathing, while the same incessant movement which draws in the fresh water circulates it over the gills, and in turn sweeps it out as waste material from the shell. The oyster implanted in its bed, or the mussel attached by its "byssus" or "beard" to the rock, exhibits a half-open condition of the shell as its normal state. The animal lives—as may be seen on looking at a tub of oysters as they lie amid their native element—with the shell unclosed for purposes of nutrition and breathing. If, however, we tap the living oyster or mussel ever so lightly, we find the shell to close with a snap that renders the persuasion of the oyster-knife necessary for its forcible unclosure. In such a case the animal's senses, warned of possible danger by the tap on the shell, communicate to its muscular system a nervous command, resulting in a movement which, as regards the oyster, reminds one of nothing so forcibly as the cry and action of "shutters up" in a Scotch university town when snow-balling begins.

The muscular system of these shell-fish is disposed in simple fashion. Look at the inside of an oyster-shell, and note the thumb-like impression you see occupying a nearly central position. This is the mark of the "adductor" muscle of the oyster, or that which draws the shells together. The secret of successful oyster-opening is simply the knowledge, acquired by much practice, of hitting the exact position of the "adductor" muscle, and of dividing its fibers with the knife. The enormous power of this muscle to keep the valves in apposition can be appreciated most readily, perhaps, by the amateur "opener" of these bivalves. In the mussel there are two such "adductors," one at either extremity of the shell, and we note the impressions which these struct-

ures leave on the shell's interior. The latter animal has thus a double hold-fast, whereas the oyster has but a single one. If the function of these structures is thus concerned with the *clôture* aspect of bivalve life, how, it may be asked, is the opening of the shell provided for? This is exactly the point to which Nature directs her energies in arranging her economical disposition of the oyster or mussel constitution. We have seen that the natural and persistent state of oyster-life is a condition of unclosure, while the opposite action of shutting the shell is only a transitory and infrequent phase of bivalve existence at the best. There is afforded a chance for the exercise of mechanical expediency in making the open state of the shell a matter of ease, and one carried out without effort or exercise of energy. And so is it contrived.

Suppose that, placing two oyster-shells in their natural position, we insert a piece of India-rubber between the valves at the point where they are hinged together. If we now forcibly close the shells by pressure, the India-rubber is compressed. When we release the pressure of our fingers, the elasticity and recoil of the India-rubber forces the valves apart. In such a fashion, then, does Nature provide for the constant maintenance of the unclosed condition. The "ligaments" of the shell are natural elastic pads existing at the hinge-line. By their elasticity they keep the valves unclosed. There is no strain involved in the action, which is a merely mechanical one, after all. But when the more infrequent act of closure has to be performed, then muscular energy requires to be displayed. The quick snap of the valves reminds us that muscular exertion, even if necessitating vital wear and tear, has its corresponding advantage in the rapidity and effectiveness with which it provides for protection against the entrance of disagreeable or noxious elements into the internal arrangements of oyster or mussel life. There is illustrated here a clear saving of life-force, and a persistent system of vital economics in the substitution of a mechanical for a muscular strain where the maintenance of the open state of the shell is concerned.

Returning to the human domain for a final glance at our subject, there are found in the spheres of digestive nervous actions many facts and examples proving the exercise of a constant economic surveillance of our life. The digestive duty may be defined as that whereby our food is converted into a fluid capable, when added to the blood, of repairing and replenishing that fluid. To this end, as is well known, the nutriment has to pass along the tube known as the digestive system, and to be subjected to the chemical action of the various fluids or secretions which are poured upon it in the course of its transit. In the stomach, for example, certain important food-principles—those of nitrogenous kind—are first selected as it were from the nutriment, chemically altered by the gastric juice, and rendered capable of being absorbed into the system. Instead of waiting for a lengthened period

for the arrival of this important part of its commissariat, the body receives such food-elements soon after digestion begins. The fats, starches, and sugars are, on the contrary, passed onward to be digested in the intestine. They become available for nutrition only after several hours of digestive work. The principle of "small profits and quick returns"—itself an economical and commercially satisfactory mode of doing business—is illustrated in the digestive transactions of the body. That which is urgently required for the frame is quickly supplied, while the (in one sense) less important foods are left for later absorption.

In this economical work the liver plays an important part. Long ago in physiological history that organ was regarded simply as a bile-making machine. The bile, thrown upon the food just after it leaves the stomach, was regarded as an all-important digestive fluid. To-day we have entered upon entirely new ideas of the liver's work. As Dr. Brunton has aptly put it, the liver is no more to be regarded as a mere bile-maker than the sole use of an Atlantic liner is to be found in the manufacture and display of the water-jets which issue from the sides of the ship as the waste products of her engine-work. The liver is really a physiological constable placed at the entrance of the blood-circulation. Into it are swept digested matters. These are further elaborated and changed so as perfectly to fit them for entrance into the blood. When the functions of the liver are suppressed or rendered inactive, elements of deleterious kind are apparently allowed to enter the circulation, and thus produce all the symptoms of the body poisoning itself. This being so, we begin to see that the bile is really a mere by-result of the liver's work, as the condensed water of the steamer is the consequence of the real function of the vessel. Bile is a waste product, and as such it is discharged into the intestine and thus excreted.

But natural economics rule life's actions here as elsewhere. For the apparently useless bile, Nature finds a use. It is discharged upon the food, and mingles with the half-digested nutriment. It has come to exercise a digestive or dissolving action upon fats, a function aptly illustrated by the household use of the "ox-gall" to remove grease-stains in the house-cleaning periods of human existence. Moreover, the bile would appear to aid in promoting the muscular contractions of the intestine, and in thus expediting digestive action. It may possess other duties still; but enough has been said to show that the economy which rules living functions is probably nowhere better illustrated than in the utilization of bile, as a waste product, in the normal discharge of the digestive act.

Turning, lastly, to the nervous system and its work, we may find exemplified equally manifest phases of economical action. When we reflect upon the fact that higher life is a tremendously complex matter in its nervous and mental phases alone, we may well be tempted to

wonder that we really find time for all the acts involved in the exercise of even our ordinary work. The condition of the brain and nervous apparatus at large might at first sight appear to represent that of an overworked signal-box at an important railway junction. Questions of commissariat, of threatening danger, of demands for information, of difficulties to be cleared away, are perpetually presenting themselves to the nervous apparatus for solution. Yet it is plain that many complex acts, the knowledge of which costs us a deal of trouble to acquire in early life, are not only performed correctly in the absence of all that we may name conscious thought or attention, but are discharged the more efficiently because they are so unthinkingly performed. What we term "automatic" action in human and in lower animal life is only another name for an economical dispensation of bodily work and of the time that work demands for its performance. Reading and writing do not "come by nature," but require to be taught, and from the "A-B-C" stage of the one, the "pothooks-and-hangers" stage of the other, both demanding thought and care, we work our way slowly upward to a phase when we neither need to think about our "p's" and "q's" in writing or our syllables or sounds in reading. In other words, the intellectual operations of early life have become the "automatic acts" of adult existence. The immense saving of nerve-power—or at least of the highest powers we may collectively name "thought"—involved in such an arrangement may readily be understood. We have not even to waste brain-work in the conduct of our steps in walking. We avoid our neighbors and the lamp-posts without concerning ourselves about either. How large a part of our life is automatically ordered, a superficial glance at the history of the nervous system will disclose. The digestion of food, the circulation of the blood, breathing, and many other functions on the due performance and nervous regulation of which the continuity of life depends, are all discharged in this automatic manner.

There is implied herein a large saving of that vital wear and tear of which we have already spoken. Life would indeed be far too short for the safe and satisfactory discharge of the duties of even the humblest life—to say nothing of the performance of merely physical duties of existence—had we to "mark, learn, and inwardly digest" every act in our daily round of labor. We may grumble as we please at overwork, and criticise rightly the evil effects of overstrain; but we should also bear in mind that the nature we own has saved us many a worry and many a pang by the exercise of that system of rigid economy which is traceable, in one form or another, in well-nigh every phase of the life universal.—*Longman's Magazine.*

THE NATURE OF PLEASURE AND PAIN.

By ALFRED FOUILLÉE.

PLATO and Aristotle have well said that neither pure pleasure nor unqualified displeasure exists in man. Both feelings are mixed in unequal proportions by the subtile art of Nature, and the definite impression on our consciousness is a resultant in which one or the other of the elements predominates. The complexity of all emotion may be deduced from the two dominant conceptions of modern physiology. One of them is that our bodies are in reality societies of cells, each of which has its own peculiar activity, and which contend with one another for existence. Among the lower animals each part of the organism appears to enjoy or suffer on its own account, as is exemplified when a worm is cut in two. Among the higher animals a selection and final fusion of the impressions takes place, centering in the brain.

The rudiments of agreeable and disagreeable feeling probably issue from all the parts, and are re-echoed in the general consciousness in such a manner as to communicate to it a timbre of pleasure or pain, according to which elements prevail. Our pains and pleasures would thus be a kind of summary of the elementary affections of a myriad of cells, and our individual comfort or discomfort a collective and social comfort or discomfort. The doctrine of evolution, and of the accumulative effects of heredity in the individual, also confirms this view of the collective character of our sensibility. Not only the present, but the past also, resounds in us; our feelings, even apparently the most novel ones, comprise the unconscious recollection and echo of the experiences of a whole series of ancestors.

Mr. Spencer remarks that the sight of a landscape excites within us certain deep but now vague combinations of states of feeling which were organized in the race during barbarous times, when its pleasurable activities were chiefly among the woods and waters. Mr. Schneider, in his "Freud und Leid des Menschengeschlechts," inquiring why the contemplation of a sunset gives us an impression of calm and peace, says: "There is but one answer: Because for unnumbered generations the view of the setting sun has been associated with the end of the day's work and a feeling of rest and satisfaction." This is saying too much, for the intrinsic effects of the colors and the freshness of the evening air, and our personal recollections, have much to do with these emotions. But it is safe to assume that the calm which the hours of repose have brought to the human race for centuries is reflected in us at the evening hour.

The study of pleasure and pain is thus analogous in complication and difficulty with social science, in which mutual actions and reac-

tions seem, by virtue of their variety and multiplicity, to escape the grasp of calculation. It is not a matter of surprise that philosophers are at variance respecting the nature of these affections. There is hardly a more interesting question before investigators than that of their origin and their office as motive powers in universal evolution. We propose here to examine into what is true and what is incomplete in the explanations of these matters that have been borrowed from the doctrine of natural selection.

We can not fail to apply the biological doctrine of selection to pleasure and pain. Mr. Schneider goes to it for the inmost secret of our joys and sufferings. Not only is there a connection between pleasure and the increase of vitality, but this connection is imperatively established as a necessity of evolution. Pleasure, according to Mr. Spencer, is a feeling which we seek to bring into consciousness and retain there, and pain is a feeling which we seek to get out of consciousness and to keep out. If we could imagine beings to have ever been created by any sport of Nature, whose pleasure was connected with injurious actions and their pains with useful ones, they must have died out speedily by virtue of the vice in their constitutions. According to Darwin's principles, the essential condition of the development of life through ages is that agreeable acts be also, on the whole, favorable to development. This is a mechanical necessity.

Mr. Schneider is so confident of the accuracy of the natural mechanism, at least for the generality of cases, that he is almost ready to believe that Nature is never mistaken when abandoned to herself. "In the normal condition," he says, "the feelings always tend to their true end; errors originate only in the morbid conditions ingrafted upon Nature by civilization. With the natural and healthy man the feelings are healthy, so that with every thought is associated a feeling of corresponding and suitable intensity." Abnormal relations appear chiefly among cultivated men, particularly among those who are diseased by their own fault or by that of their ancestors. "The passions have much less spread in the healthy and simple populations of the country than among the very artificially trained inhabitants of the large cities. Practical right and good conduct are much more dependent on health of the body than on health of the mind."

The exaggerations of the Darwinian theory begin, in our opinion, at this point. A mechanism of pleasures useful to life, once produced, is, without doubt, transmitted by heredity and becomes almost infallible in the lower species; but no infallibility can be found in the higher animals, not even in those that have the *mens sana in corpore sano;* for, the more the organs become complicated, the more does a purely mechanical selection become difficult for them. An idle or unintelligent man, for example, is not hopelessly condemned to death by the justice of universal mechanism, for he has more than one way of escape. If one faculty is under restraint, another one can come to

its help. Moreover, mechanical adaptation to the medium becomes a matter of more difficulty as we ascend in the scale of beings; and from this arise many anomalies. Individuals retain tastes which were formerly favorable, but are now useless or injurious, as the passion for hunting and the warlike disposition, which are, according to Mr. Spencer, relics of savage instincts. Other anomalies arise in consequence of an antagonism between the individual and the species, as when the lower animals destroy themselves by division to make new beings, and some of a higher grade die immediately after performing the act of reproduction. Mechanical selection is likewise incompetent to give an explanation of the origin of pleasure and pain, and to throw light on their primitive connection with life. We believe that there is a close and strong bond between these affections of life, independent of natural selection, which modifies and perfects the connection, but does not create it, and that we can find the reason of this connection by inquiring of physiology and psychology.

Let us inquire, first, what physiology can teach us about it. In previous investigations in this direction we have reasoned too much from complex organisms already developed. The thing we ought to learn is what, in a cell or a nerve, arouses the rudiment of pleasure or of pain, to be extended ultimately to the whole of the living body. The nervous elements are constantly the scene of a double chemical labor; a "negative" work of reparation, consisting in the formation of very complex albuminoid compounds; and a "positive" one of expenditure, consisting in the reduction of these compounds to more simple ones. In the state of repose, these two molecular labors are performed simultaneously, and are nearly in equilibrium. In that case we are conscious simply of a condition of vital calm and evenness, with which is connected a vague feeling of rest and comfort. An external agent, a sound, a light, or a shock, comes to excite a nerve; the interruption of the equilibrium produces a movement of nervous expenditure, and this excites a simultaneous movement of reparation—just as water flowing out of a siphon-tube calls up into its place water which rises. These two labors are equally necessary to life, and must be suitably proportioned to one another for life to subsist. Nervous reparation, which accumulates force, always has for its result and object exercise, which expends force. In natural selection, the animal can not be satisfied with repairing his nervous system; he must put it to use, to seek food and defend himself; he must expend, to preserve. This being so, can we assume, as Léon Dumont does ("Théorie scientifique de la sensibilité"), that the accumulation of force, its "storage in the nerve," is the only cause of pleasure? Every nervous action, says this author, is an expenditure of force. How can expenditure, which is a loss, produce pleasure, the cause of which, on the other hand, is sought in augmentation of force? This view arises from an imperfect conception of the relation of the two molecular labors. The

visible labor of expenditure in walking, speaking, looking, hearing, etc., is doubtless, for the instant, a loss of motive force; but then, as we have just seen, there is in an adequately fed organism reparation of the nerve by nourishment in the measure that it is worn away by exercise. Simple rest is also a sufficient condition of reparation. There is, therefore, no absolutely definitive loss. Furthermore, exercise produces skill in reducing resistances and obstacles; and, when it is moderate and agreeable, it increases and feeds the organ instead of enfeebling it. Want of use, on the other hand, produces atrophy of an organ. Thus, normal exercise, expenditure proportioned to the force, is a necessary condition of reparation, conservation, and progress. Natural selection is therefore a law of work, of incessant expenditure; but the action fortifies, and the expenditure enriches. This means that life supposes incessant recomposition and decomposition, and consequently movements of disintegration as well as of integration. To feel life is to have an obscure perception of all the vital movements; to enjoy or suffer is to feel one's self living more or living less. The more intense the decomposition with an equally intense recomposition, the more precipitous is the vital movement, and the more we feel. It is not, therefore, to adopt the language of mechanics, the potential force, but its transformation into living force and into movement, that causes pleasure—provided the expenditure does not exceed the reparation necessary for the survival of the individual and the species.

Experiment confirms the deductions which are drawn from the laws of natural selection and of the struggle for life. Every normal and proportioned action of a well-fed nerve causes enjoyment; and the pleasure increases with the force of the stimulant to the point where the stimulation and the expenditure which it involves exceed the compensatory labor of reparation. Pain is due to the exhaustion, or the destruction, or the rupture, of the sensitive tissue; disorders which if prolonged would induce the death of the individual or of his posterity. The proportionate or disproportionate exercise of a particular nerve thus extends its effect, by diffusion and sympathy, so that it makes itself felt by the whole of the nervous system, and consequently of the organism. Hence, in the struggle for existence, four situations are possible when considered as to the relation of the expended to the accumulated energy, of the labor produced to the nutrition: 1. An excess of acquisition with insufficient expenditure produces the negative pain of want—the well-fed child suffers from immobility. 2. An increase of expenditure succeeding an increase of nutrition produces the positive pleasure of exercise—the child takes delight in running, jumping, and playing. 3. An increase of expenditure with insufficient reparation produces fatigue and positive pain—a too fast or too long race brings on weariness. 4. Absence of expenditure after exhaustion produces the negative pleasure of rest.

It appears to us that, by a psychological interpretation of physiological facts, these laws can be reduced to one superior and really primitive law. Some have sought the meaning of the law of proportion, which demands that the positive labor of exercise bear a just relation with the negative labor of reparation, in the theory of a just mean, or a kind of golden mediocrity, by which the fundamental law of sensibility would be equilibrium, not action pure and simple. This is confounding the limit of a thing with its essence. Moderation, in itself, is not pleasure, nor the primitive law of life. It is a necessity which life encounters and submits to according to the needs of the organism. The true primary law is that pleasure is connected with the most intense possible activity; and this is, besides, the true condition of superiority in the struggle for existence. For this reason, if the increase of the activity or of the exercised function does not exceed the reserve of forces and wear upon the organ, the pleasure increases with the activity, without regard to moderation. If excess of muscular motion produces pain, it is because, not proportioning our actions to the strength of our organs, we wear upon them. The supposed increase of activity is then really a diminution.

Another problem is met in seeking the reason for the necessity of a change of action, for which contemporary psychologists, like Mr. Bain and Mr. Sully, have propounded the law of contrast as opposed to the laws of stimulation and moderation. It is in reality, however, derivable from the same principle as the other law. Change in action is only a means of assuring continued intensity of action. It makes other nerves to work while the former ones rest, and, effecting a separation of the nerves after this manner, augments the vital power.

To enjoy is, then, to act as much as possible with the greatest intensity, independence, and liberty. Activity, by itself, goes on infinitely. It moderates itself only by necessity and constraint, only to have afterward to moderate itself less, and to deploy itself beyond all the limits successively erected before it.

It might say, with Faust: "If ever I stretch myself, calm and composed, upon a couch, be then at once an end of me. If thou canst ever flatteringly delude me into being pleased with myself—if thou canst cheat me into enjoyment—be that day my last. If I ever say to the passing moment, 'Stay, thou art so fair!' then mayst thou cast me into chains; then I will readily perish; then may the death-bell toll; . . . the clock may stand, the index hand-may fall; be time a thing no more for me."

Activity changes, therefore, only to maintain itself, to adapt itself progressively to the medium which changes, to increase its conquests without losing its acquisitions. In the evolution of species, this expansion of activity has always been a condition of survival and of superiority over other species.

Some authors have maintained that the final intensity of the action

and its victory in the struggle for life are connected with the brute quantity of nervous excitation, independently of its quality. But this view involves difficulties. How, for example, can we explain the fact that some sounds and some odors are disagreeable in all their degrees? Again, fix your eyes upon a moderately lighted white surface; you will feel neither fatigue nor displeasure, but you will also experience only a weak positive pleasure. Substitute a blue surface for the white one. The blue ray, which was previously present in the white light as one of its constituent elements, is now offered separately to your eye, with the other rays eliminated, and your pleasure is increased. The increase of pleasure can not be due to an increase of stimulus, for the physical stimulus has been in fact diminished by the quantity of light that has been eliminated. Your pleasure is no more due to a diminution of fatigue, for there was nothing fatiguing about the white. The agreeable nature of the blue is therefore associated with the mode rather than with the degree of nervous action. An effect of heredity and selection is also involved. Animated beings have for many ages received the blue rays from the sky under which they lived, and they have become hereditarily accustomed and adapted to this luminous medium of clear days as well as to the green rays of the fields and woods. It is, however, impossible to account for the details of our sensory pleasures any more than for our æsthetic pleasures. All that can be said is, generally, that the form or quality of the excitation must be taken account of, as well as its quantity.

If we examine the directions toward which the movements of the organisms ultimately tend, we shall find that some tend to the preservation of the substance, others to its destruction; some to life, others to death. Pleasure is of victory in the struggle, of life, pain of defeat, of death. All suffering is a partial death which comes upon some organ or function. Darkness makes us sad because it extinguishes the sight; discords, because the jangle of noises afflicts our perception of sounds. Thus, everything that tends to obstruct and annul a function of the senses produces annoyance and pain. So with mental functions. We enjoy what we can understand clearly, for it implies life and vigor of thought; we are pained when we fail to understand anything clearly, because that conveys an impression of impotency of thought. The emotion of the sublime involves a mingling of sorrow and joy, because, in the immensity of that which excites it, the possibility of perceiving the whole, of comprehending it all in our eye or even in our imagination, is taken away from us; but, by a superior effort, we conceive the infinite, and annul the material obstacle by the power of thought. We thus, at the same time, feel a physical inferiority that depresses us, and a moral superiority that raises us: we die in the world of sense, and are born again in the world of mind.

While Darwin discusses the struggle for existence, he does not

consider the question of why beings should live, or should desire to live; or why there are agreeable and useful variations which the being should make an effort to preserve. Now, external selection evidently presupposes an internal spring, of necessity or spontaneity, which produces, with life, the bound toward a higher life, the bound of evolution. A German biologist, Mr. Rolph, looked for this spring in the movement of assimilation by endosmose, which is characteristic of all organized beings, or of all individual cells, and which he assumed to be insatiable. In this view, we might then speak of a "mechanical hunger," or craving, as the cause of all the actions of living organisms. Corresponding with this "mechanical hunger" appears, at a particular stage of evolution, what Mr. Rolph calls "psychical hunger," which makes itself felt at first essentially as pain; while pleasure is only "a secondary and derivative phenomenon." Hence it results that pain is the motive spring of the universe. This theory is intimately connected with the doctrine which assumes that the essence of pleasure, or at least its necessary condition, is the suppression of pain. Leibnitz has mentioned those infinitesimal and imperceptible "little griefs" which, being suppressed, give "a quantity of half-pleasures," the continuation and accumulation of which, "as in the continuation of the impulsion of a grave body, which gains impetuosity as it falls," become at last a real and whole pleasure. "And at the bottom," he adds, "without these half-griefs there would be no pleasure, and we should have no means of perceiving that anything aids and relieves us by removing the obstacles that hinder our setting ourselves at ease." An Italian philosopher of the eighteenth century, Verri, developing Leibnitz's thought, came to the conclusion that a pain precedes every pleasure; and the theory has been followed up by Kant and Schopenhauer and the pessimists.

To resolve this question which the pessimists have raised, we must inquire whether there are any pleasures that make themselves felt directly, without the intervention of a previous pain; and whether there can be motives to activity without the assistance of pain. It appears to us that the pleasures of the higher senses, of sight, hearing, and smell, and the mental pleasures, and those of science and art, belong to the latter category. A child, seeing a scarlet cloth for the first time, gains an excitation of the sense of sight which is in no way the suppression of a previous pain. To invoke in this case imperceptible uneasiness and latent wants, and a tension of the optic nerve aspiring to fulfill them, is to form a hypothesis which has a part of truth, but does not wholly explain the phenomena. The pleasure here is not simply the exact filling of a void, or the adequate satisfaction of a pre-existing want; it is a surplus, an addition. If we regard the scale of intensities in sensation, we shall find that there is a point near to indifference, departing from which some pleasures are capable of arising by an increase of intensity. Not every pleasure supposes a previous

descent below the ideal point of indifference into the lower region of pain. Pleasure, then, is felt directly as such, and not indirectly through a pain which it replaces; and the sight enjoys without having suffered.

Modern physiology teaches us that the higher sensibility is connected with special organs, like the eye, the ear, the nose, and the mouth, while inferior sensibility is diffused through the body, without connection with well-differentiated organs. Inferior sensibility informs us of conditions that are material to our existence, as contact, hunger, thirst, etc., and it has been organized through natural selection so as to be alarmed when these conditions are threatened. Hence, inferior sensibility is better adapted to suffering than to enjoyment. The higher senses, on the other hand, particularly sight and hearing, respond less to the needs of life than to superfluity, to conservation than to progress, and are better adapted to pleasure than to pain. It results from this that the mutual relations of enjoyment and suffering are inverse for the higher and the lower senses. For general and internal sensibility, for the sense of temperature or of touch, a distinct pleasure presupposes some antecedent uneasiness or want. It is pleasant to eat or drink when we are hungry or thirsty, and to plunge into fresh water when the skin feels hot; but, if, when we eat or drink without previous hunger or thirst, we feel pleasure, it is because of some particular effect of the aliment on the specialized sense of taste. So, when the body is at the normal temperature, heat or cold will give it but a slight gratification. Contrast with antecedent pain seems in these cases to be necessary to present pleasure. On the other hand, only a slight degree of divergence on the side of pain, as in the case of a burn, a blow, or a colic, is enough to cause considerable suffering.

An opposite law rules in the higher senses, and particularly in those which have very specialized organs. In them pleasure arises immediately, and is capable of acquiring a notable degree of distinction at the very start from the point of indifference. This takes place in excitations of the sight, hearing, smell, and tase. In return, the higher senses are less subject to suffering than to simple annoyance. A discord, a piercing whistle, inharmonious colors, a dazzling light, and a disagreeable odor, do not provoke any pain of the hearing or vision comparable in intensity to that of a wound or a burn. These, we believe, are the real scientific reasons why the higher sensibility is free from necessity and "hunger," while the lower sensibility is enslaved to them.

If we compare the higher with the lower senses in respect to their activity, we shall find that a greater specialization corresponds with a lessened passivity, and a greater share of central activity and willpower. We have but little control over our internal organs; we can not, for example, put our stomach or our heart into the active attitude

of attention; but we can at will look, hear, smell, taste, or touch. Now, pleasure precisely corresponds with this higher activity.

Between the higher and the lower senses is a kind of intermediate class, the importance of which has not hitherto been sufficiently remarked—we mean muscular sensations, or sensations of resistance, which many philosophers regard as the base of all the other sensations. Now, in the movement of our muscles, in which our activity is continually applied to overcoming a resistance, and in which, therefore, we are perpetually active and passive, we see the pleasure of exercise and the pain of fatigue drawn clearly one upon the other, according to the exact relation that exists between our muscular force and the external resistance. This essential fact clears up the rest. It shows the intimate and primitive connection of pleasure with activity, and of pain with passivity. The possible independence in respect to necessity and pain manifested by the highest senses is still more remarkable in the intellectual, æsthetic, and moral pleasures which may even come without being sought. Of such is the pleasure of surprise. The first shooting-star that passes before the eyes of a child charms it without having been anticipated or desired. A discovery made without having been sought is a happy chance, a pure gain, an unexpected inheritance. For all these reasons we assume that there exist pleasures of surplus which attend an excess of activity or stimulation. In them the same cause excites activity and satisfies it, without the intercalation of any want, of any "mechanical or mental hunger" or unsatisfied desire. Kant's doctrine that one pleasure can not immediately succeed another without the interposition of a want or a pain is contradicted by the facts. If, while I am eating savory meats, I unexpectedly hear fine music and am surprised by the spectacle of graceful dances, I experience an increase in which pleasures are added to one another without my having to go through the gate of suffering. Furthermore, a progressive increase of pleasure would be impossible under Kant's theory, which supposes the necessity of successive breaks, or interrupting pains. Mr. Schneider believes that we are conscious of an agreeable feeling only when we perceive a change for the better, and of a disagreeable one when we perceive a change for the worse. His theory ends in the same vicious circle as Kant's: "We must suffer to be able to enjoy, and must enjoy to be able to suffer." How, then, do we get joy or suffering in the first place? The theories of Schopenhauer and Hartmann involve similar fallacies.

We have just shown that there exist direct pleasures, due to a surplus of activity without previous pain, the simple object of which is not the preservation of the organism in the struggle for life. We may go further, and ask if all pleasures, even those which appear to originate in a want, even those seemingly the grossest, are not of the same nature to one who looks to the bottom of the matter.

Does the complete satisfaction of a want, even of a physical one,

consist only in filling a pre-existing void, without anything more, and thus simply re-establishing an equilibrium? If it were so, the equilibrium would produce a mental condition of consciousness and feeling, or immobility, and there would be no evolution. What causes enjoyment in satisfying a want, such as the want of food or exercise, is that there is, relatively to the previous condition, a surplus, and hence a movement of progression in which is continuously produced an excess as compared with what we have just got, and we are enriched above our previous poverty. It is not, therefore, simple suppression of pain that constitutes sensual enjoyment, for that would be merely neutralization of the former condition by the after condition. Enjoyment is constituted by the suppression of pain *plus* an excess, which produces a progress, not a rest, of activity. The painful condition of hunger is composed of an infinite number of rudimentary pains. The pleasure which we feel in restoring our forces is a continual victory over these rudiments of pain, and produces something like the accelerated velocity of a moving body. But a continual victory is a continual surplus, and it is this surplus that makes the pleasure. Hence, not only does pleasure not require for its existence a previous want, but even when it succeeds a real want, as in many of the pleasures of the senses, it is nevertheless in itself independent of the want, or essentially positive. We can not, then, with Messrs. Leslie Stephen and Delbœuf, locate pleasure in the simple feeling of a normal equilibrium. Even in the act of eating, the pleasure felt incites the expenditure of energy, and the equilibrium is not reached till satiety causes the action to cease. The feeling of equilibrium only constitutes a general and fundamental comfort, very near to indifference. We can not be satisfied, either, with saying, with Mr. Spencer, that equilibrium is the accompaniment of normal action. To our mind pleasure, as a distinct emotion, appears precisely when the limit of normal action has been passed, for it supposes, at whatever point, a richness. We go, then, to the end of the way opened to us by the great philosophers, and define pleasure as the feeling of a surplus of activity. Its relation to pain only marks the beginnings, not the end, of evolution and selection; it is primary, but not definitive; it is accidental, but not essential.

We now turn to the final and fundamental question—Is pain the sole motive to activity, and consequently the real motive power of universal evolution? This discouraging doctrine may be found among other psychologists than Schopenhauer and the pessimists, and they have not always drawn from it the moral, metaphysical, and religious consequences that they might have drawn. According to Mr. Leslie Stephen, pleasure, being a condition of equilibrium, is for that reason a state of satisfaction in which there is a tendency to persist. Mr. Rolph ("Biologische Probleme") remarks that it is a state which we seek to prolong, and can therefore never be the cause of a change of condition. When it is objected to this, that man—when, for example,

he is under the influence of love—may seek a greater pleasure than the one that is present, and that the object of his action, in that case, consciously or unconsciously, is certainly pleasure, he replies, "Yes, but the actual motive is a feeling of non-satisfaction, which is the same as pain." This theory touches what are the most obscure as well as most important problems of psychology and morals. In our opinion, the doctrine of pain, as the motive of action, could be true only if all activity were solely applied to change toward another condition. Of this character are effort, want, and desire; hunger, thirst, hope, and anger. But is it certain that all activity consists thus exclusively in moving toward another condition, as a mobile material object moves toward another point in space? Is change, or unquiet, as the ancients said, the essence of action, or is it only the result of the limits of action, of its deficiency, or of the external resistance which it meets? Present enjoyment, such as the enjoyment of agreeable sounds or beautiful colors, so far as it is complete, and considered in itself, does not provoke the desire for anything else, is satisfied with itself. Does that mean that it is constantly passive and inert? From the circumstance that the action of the living being, being never solitary, is always exerted toward a point of application which itself reacts, it results that change is attached to activity, as a necessity of the resistances of the medium, if not of its essence. At the precise moment and in the measure that we are enjoying our active state, as in the contemplation of a scene of nature, we cease to desire change as Mr. Rolph and Leslie Stephen maintain; but no enjoyment and no action can continue long at the same level of intensity. The prolongation of the exercise and agreeable stimulation of the nerves tends to diminish the effect, according to the law of wear-and-tear. It is the feeling of this diminution, of this constant decline, in which pleasure betrays itself, which is the real excitant of the always reviving desire or hunger. But in this case the hunger is revived, because the former comfort, which existed independently of it, feels itself menaced, diminished, exhausted, and escaping as it were from itself. The pain is pleasure's cry of alarm, but pleasure does not essentially imply pain.

We see then, anew, that what is really primary is the action, the same in being and in comfort, from which arise, with external resistance, distinct pain, and, with victory over the resistance, distinct pleasure. Change, motion, and progress have their reason in the perfection of activity; but enjoyment is, as Descartes, Leibnitz, and Spinoza believed, the feeling of some actual perfection come to realization of some power.

In wholly absorbing activity into disquiet, want, or hunger, Mr. Rolph has only discerned half of the truth. He has not insisted enough on the counterpart of hunger and nutrition, which is the disengagement of force and movement. Like Darwin, whose doctrine he desired to perfect, he has considered principally the support and

development of the organs, not their exercise and the development of their functions. Hunger, regarded by him as the primary and universal feeling, has for its object the appropriation of matters coming from without. It is a force of concentration and absorption into itself. But, as we have seen, nutrition and the restoration of the organs, which simply store up the forces of tension by a kind of negative work, are not the real source of positive pleasures or of positive pains. It is in expending the energy of materials already appropriated that we feel pleasures and pains. In that way are brought about the development of the being and evolution toward new conditions of life: the living being acts upon the medium, and the medium is in turn modified by the increasing power of the being. There is, therefore, in animated nature a development from within to without, and not only a kind of envelopment and absorption from without by that which is within. The acquisition and restoration of the tissues suppose a certain activity already present, an anterior outbreak of life manifested by movement; and it is plausible to suppose beneath this vital movement, preceding the rudimentary pain caused by the exterior resistance, the rudiment of pleasure attached to the interior action.

The conclusions to which our study appears to have brought us are not less important for the theory of morals than for the theory of man and of the world. The first is, that natural selection, a wholly mechanical and exterior process, presupposes an internal principle of evolution, which principle is an activity capable of enjoying and suffering. A second conclusion is, that pleasure is immediately connected with action, and comfort with existence and the unfolding of life. Hence it follows that pain is not, as some of the pessimists believe, the principle of internal action and desire, but only that of the reaction on the external world.

Extending these results to the general theory of the world, we can infer from them that pain is not the sole motive of universal evolution. It is only at the origin of evolution that uneasiness, pain, or hunger, is the principal spur of which Nature avails herself. But in a higher degree in the scale of beings, pleasure, through the intervention of the thought that anticipates it, becomes the certain stimulus to activity. Hence, we have seen the higher senses effecting rapid condensations of an infinity of delicate and subtile pleasures, objects of luxury rather than of the necessities of material life; and evolution becoming a child of wealth, and not a child of poverty only. For this reason evolution does not seem to us to be solely "preservation of self," according to Darwin's term, or "maintenance of the normal equilibrium"; but it is, or may become, a progress. Pain, therefore, is not, as Schopenhauer and Von Hartmann maintain, the eternal and irremediable condition of beings, a kind of damnation, or a hell from which the world can not escape except by annihilation of itself.

Still other moral consequences, no less important, are brought out

If hunger and inner nutrition are not the only law of being, if expenditure from self to without is also a fundamental and essential law, it results that egotism is not radical, and activity may really become loving. The being does not tend solely to bring everything toward itself, as if by a gravitation of which it is the only center; but it tends also to extend, to give, and to join itself. Utilitarianism, Darwinism, and Spinozism are passed by. Enjoyment, "pure and veritable," which is not merely a remedy for pain, thus becomes apparent as the overflowing activity, which feels itself at last free from obstacles, superior to what was strictly necessary for the satisfaction of want; it is no longer a simple balance, but a profit, and, as we think we have shown, a surplus. It is, therefore, in the domain of sense, something analogous to what in art causes pleasure by excellence, and realizes the supreme charm—grace. Grace is produced by a superabundance, resulting in enfranchisement from the rude struggle for existence, freedom and ease of motion, facile play of thought, expansion of the heart, and generosity of the will. True pleasure is the grace of life.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

SKETCH OF FREDERICK WARD PUTNAM.

By CHARLES C. ABBOTT, M. D.

OF the long series of living American scientists, probably no one is more generally and favorably known than Frederick Ward Putnam, Curator of the Peabody Museum of American Archæology and Ethnology, at Cambridge, Massachusetts, and Permanent Secretary of the American Association for the Advancement of Science.

Brief reference to Mr. Putnam's ancestry will prove of interest. He is a lineal descendant of John Putnam, who came from England, *circa* 1634, and whose family became very prominent in Salem, Massachusetts, particularly during the witchcraft delusion. A glance at the Putnam genealogy shows how large a proportion of the prominent people of that historic town, Salem, are included among his ancestors—Fiskes, Higginsons, Palfreys, Hathornes, and others. The same is true of his mother's family, the Appletons. As was the case with the Putnam family, the great majority were graduates of Harvard College, one of them, the Rev. John Rogers, being president of that institution.

Mr. Putnam was born at Salem, April 16, 1839, being the youngest of the three sons of Eben and Elizabeth Appleton Putnam. In very early life he evinced a fondness for natural history, which his parents wisely encouraged, and he was fortunate also in living in a town where was maintained a most excellent zoölogical museum.

Putnam's active scientific career dates from his election to mem-

bership of the Essex Institute, in 1855, he being then in his sixteenth year. In 1856 he was made curator of ornithology and cabinet-keeper. In the thirty years that have since elapsed he has taken an active part in the Institute, holding many important offices, and since 1871 has been its vice-president. It was in 1856, also, that he was elected a member of the Boston Society of Natural History, and here, too, his ability as a naturalist was promptly recognized, as shown by his being placed on many important committees, made a member of its Council, and in 1880 vice-president, a position which he still holds.

In February, 1856, a most important step was taken. Putnam entered the Lawrence Scientific School, and became a special student under Professor Agassiz. In a few months, Professor Agassiz made him an assistant at the Museum of Comparative Zoölogy, in special charge of the collection of fishes. In this capacity he remained until 1864, when he married and removed to Salem, to take charge of the Museum of the Essex Institute.

In August, 1856, Putnam joined the American Association for the Advancement of Science. In 1869, during Professor Lovering's absence in Europe, he acted for him, in the office of permanent secretary, and during this time was also local secretary of the Salem meeting. In 1873, on the resignation of Professor Lovering, he was elected permanent secretary, and has been re-elected three times, and is now serving his fourth term of five years, being, under the old and new constitutions, a continuous tenure of thirteen years. When elected to this responsible office, in 1873, the Association barely numbered five hundred members, and now has a membership-list of over two thousand names. It is unquestionable that this increase is largely due to Professor Putnam's executive ability and thorough realization of what such an association needs to make it a success.

In 1867 the trustees of the fund given by the late George Peabody for the promotion of science and useful knowledge in Essex County, Massachusetts, appointed Putnam Superintendent of the Museum of the East India Marine Society and the scientific collections of the Essex Institute, which the trustees had received as a permanent deposit, with authority to reorganize and arrange them in the East India Marine Hall. On the incorporation of the trustees of this fund, given by the great philanthropist, under the name of the Peabody Academy of Science, Putnam was appointed Director of the Museum, and held the office until he resigned in 1876, when he removed to Cambridge.

In 1868 the degree of A. M. was conferred upon Putnam, by Williams College, where he had lectured on zoölogy and aided in the scientific arrangement of the natural history collections.

In 1874 Putnam was an instructor at the School of Natural History on Penikese Island, taking charge of the school at the opening of its summer term, during the illness of Mr. Alexander Agassiz.

In this year, also, he was appointed an assistant on the Geological Survey of Kentucky, and passed several months in cave explorations. It was at this time that Salt and Saunders Caves were thoroughly explored and so much of archæological importance was discovered. A report of these "finds" was published in the "Proceedings of the Boston Society of Natural History." Important zoölogical results were also obtained from the same and other caves, and accounts thereof published in various journals of learned societies, and subsequently issued as a separate volume, under the joint authorship of F. W. Putnam and A. S. Packard, Jr.

In September, 1874, on the death of Professor Jeffries Wyman, Putnam, at the request of Professor Asa Gray, took temporary charge of the collections of the Peabody Museum of American Archæology and Ethnology, in connection with Harvard University. At the annual meeting of the board of trustees, in January, 1875, Putnam was appointed Curator of the Museum. That such action should have been taken was most natural, as Professor Gray, in his single brief report as curator *pro tem.*, remarks: "As respects the care of the museum during the short period in which I have endeavored to act as temporary curator, while I have given to it such attention as I could, it was soon evident that the lack of time and of the requisite technical knowledge would prevent me from personally carrying on the work which had to be done. I therefore availed myself of the permission granted at a former meeting of the board, and engaged the valuable assistance of Mr. F. W. Putnam, of Salem, who is better acquainted than any one else with the museum, and with Dr. Wyman's method and arrangements, having been much associated with him both in exploration and publication." The above clearly shows that, of many who would have gladly undertaken the care of the museum, no one was so eminently fitted for the position.

In 1876 Putnam was also appointed an assistant in the Museum of Comparative Zoölogy, in charge of the collection of fishes, which duty was undertaken and continued until 1878, when domestic affliction necessitated his resignation.

In 1876 the Engineer Department of the United States Army appointed Putnam to take charge of and report upon the archæological collections made by the *attachés* of the Geological Survey, west of the 100th meridian, Lieutenant George M. Wheeler in charge. The report was finished in 1879, and constitutes Volume VII of the quarto publications of that survey. In the preparation of this volume, Putnam was assisted by several specialists; but his own hand is evident in the general editorial supervision of all parts, and the exhaustive article, covering fifty-five pages, on perforated stones, by Putnam exclusively, is one of the most complete and valuable contributions to prehistoric archæology by an American author.

As indicative of the value of his scientific labors, we find that, be-

tween the years 1858 and 1886, Putnam has been made a member or correspondent of twenty-seven learned societies in America, and of five in Europe. In April, 1885, he was elected a member of the National Academy of Sciences.

Although in recent years Putnam's attention has been given so largely to archæological investigations, his knowledge of general natural history has not been overlooked by those who best know him; and in 1882 Governor Long, of Massachusetts, appointed him a commissioner of inland fisheries for five years, and so far as practicable his attention is given to the onerous duties of this important office. By the special act of the Massachusetts Legislature, which took effect last month, he became Commissioner of Fish and Game.

Mr. Putnam's contributions to scientific literature have been many, and all are valuable. As early as 1855, communications with reference to the fishes of Essex County, Massachusetts, were published in the "Proceedings of the Essex Institute"; but his first paper of length and marked importance was the "Catalogue of the Birds of Essex County, Massachusetts," with notes; and reference to the ornithic fauna of the State at large. This paper, prepared while its author was yet in his teens, has stood the test of time, but two errors, and these unimportant, having since been detected.

This contribution to zoölogical literature was followed by thirty-seven papers on birds, reptiles, fishes, and insects, mostly native species.

In 1857, while attending a meeting of the American Association for the Advancement of Science, at Montreal, Putnam found, on the side of Mount Royal, near the site of the present reservoir, a quantity of clam-shells, fish-bones, burned earth, and pottery, and, during the following winter, called attention to them, at meetings of the Essex Institute, as evidence of the early occupation by man of that locality; that the spot was, in fact, a veritable kjökkenmödding, or, as we now call such accumulations, shell-heaps. This is among the first of such notices of ancient man in America.

In 1865, Putnam published a paper on "An Indian Grave and its Contents, on Winter Island, Salem, Massachusetts," and since then two hundred and twenty-nine papers have been given to the public.

His archæological activity may be said to date from the publication of his "Winter Island" paper, for, on looking over the long list of titles, it will be seen that, from this time, papers on early American man steadily increase in number, and the work of the zoölogist practically ceases. While archæologists have good cause to rejoice at this, it can not but be viewed with regret by the zoölogist, considering the character of the many papers on their favorite subjects.

Besides the immense amount of literary work thus briefly sketched, there is to be considered, also, Putnam's labors as an editor, for much

of the value of the "Proceedings of the Essex Institute," of the "Annual Reports of the Trustees of the Peabody Academy of Science," and of the annual volumes of the American Association for the Advancement of Science, Vols. XXII–XXXIV, is due to his careful editorial supervision. Putnam also was one of the original editors and published Vols. I–IX of the "American Naturalist."

While brief papers are continually appearing in various scientific serials, it is to the annual reports of the great museum, of which he is the head, that Putnam gives his principal attention. Already ten of these have been published under his direction, and others are in preparation. It is scarcely necessary to add that they contain an immense fund of invaluable archæological knowledge, and must, of necessity, be accessible to every one who would have a thorough knowledge, so far as it can be obtained as yet, of ancient man in America.

A perusal of these reports and a careful examination of the museum's collections at once show the eminent fitness of the man for the place, the method of conducting exploration and exhibiting the results thereof being that which a zoölogist adopts in treating of a purely zoölogical problem. It is not the design of the museum merely to group a vast amount of material together, in series of like objects, to show how varied is man's handiwork, but to let associated objects, as they occur, tell the story of the people who used them. This was the view taken by Professor Wyman in collecting the remains of ancient man from the Florida shell-heaps—he would have removed a shell-heap, bodily, to the museum, had it been practicable—and in this spirit, with by no means sufficient funds to carry on the work, Putnam has continued to labor, and succeeded in gathering a quarter of a million objects from every nook and corner of America.

Recently, the trustees of the Peabody Museum, in carrying out the objects of Mr. Peabody's trust—one of which was the establishment of a *professorship* of American archæology and ethnology—unanimously nominated Putnam for the position, and the corporation of Harvard College established the professorship.

The mantle of the late lamented Jeffries Wyman could have fallen on no worthier, abler shoulders than those of Frederick Ward Putnam.

EDITOR'S TABLE.

MORAL TEACHING IN THE PUBLIC SCHOOLS.

THE reason most frequently given for the introduction of more or less of theological doctrine into public school-teaching is that, without this, there can be no effective teaching of morality. The Roman Catholic Church has always urged this point very strongly; and other communions, if less definite in their claims, have in general shown a disposition to give the teaching of morals in the public schools a distinctly theological basis. The question should, therefore, be fairly met, whether morals can be taught apart from theology. If they can not, then there is only one thing for state-directed schools to do, and that is, to leave the whole subject alone; seeing that the teaching of a privileged and undemonstrable theology in such establishments is something the people as a whole will never consent to—something, indeed, entirely inconsistent with the most elementary notions of intellectual freedom.

By morals we understand the science or art of human conduct—the science, when studied theoretically; the art, when practically applied. We believe that the end of conduct is the promotion of happiness in the widest sense. Happiness is the end that every individual instinctively seeks; and happiness is the only end that the philosopher can discover, toward which conduct in general can be directed. Happiness, again, if a definition of it must be had, can only be understood as fullness and harmony of life; and the things, therefore, that tend to render life full and harmonious are the things that tend to happiness, and the things consequently that morality, as a science, should teach. But life is essentially a thing of relations, and of ever-multiplying relations as it grows in complexity. No human being can be understood apart from his relations to the social organism to which he belongs. As well, to use Mr. Spencer's illustration, try to understand a human arm severed from the body and without reference to, or knowledge of, the body as a whole. The harmony of individual life is consequently, in the main, a matter of adjustment to its social environment. Only through society does the individual gain a true knowledge of, or empire over, himself. Only through society does he discover his true destination in the performance of social (including domestic) duties and the enjoyment of social privileges. Only through society are his thoughts so far widened as to enable him to take a rational view of the universe, unobscured by personal illusions and undisturbed by superstition. The action of mind upon mind and the shock of opinion upon opinion are the guarantees at once of our intellectual liberty and of our mental sanity.

Now, we wholly fail to see why morality as the science of human duties, themselves considered as the foundation, the essential condition (demonstrably so) of human happiness, could not be taught very efficiently and satisfactorily in our public schools, without any reference to supramundane facts or theories. What we all have to do is to adapt ourselves to the conditions of life here; and some respectable theologians are to be found who hold that, if we succeed in doing that, we shall occupy a very good position for entering on any future life that may await us. Be that as it may, the business of adapting ourselves to our earthly environment is one that depends on a knowledge of mundane truths. Let our school-

teachers be at full liberty to expound the laws of human life and well-being to their pupils. Let them show them what they are and what they are adapted for, and how each kind and grade of happiness — physical, intellectual, moral, personal, domestic, social—attainable by human beings, depends on the wise and patient exercise of specific faculties and powers, on the steady pursuit of specific courses of action. Let him appeal less than has hitherto been done to the coarse and often hurtful stimulus of individual ambition, and more to the sense of comradeship and mutual good-will which is never wholly lacking in children. Let him exhibit civilization, as we now enjoy it, as the joint product of unnumbered minds and hands co-operating, often unconsciously, toward a common end; and let him point out that greater triumphs still are to be wrought in the future when the thought of the common good shall be present to every mind, and more or less sweeten every day of toil. The trouble with multitudes of men and women is that their true self-respect has never been properly aroused. Dreams of ambition may have been presented to their minds, but they have not been sedulously taught to consider themselves as capable of *good* things. They have heard in all probability that they have souls to be saved (or the reverse), but it has not been sufficiently impressed on them that they have characters to be refined, that they have the germs of a hundred good qualities which a little generous nurture would quicken into vigorous and beautiful life. From this point of view the old Socratic maxim, "Know thyself," acquires a new and powerful significance. To know one's self is to know one's own best capacities, and to know these is to desire to exercise them. To know one's self is to know one's weaknesses, and to know these is to be more or less on one's guard against them. In one aspect, therefore, the teaching of morals is simply the unfolding of the actual facts of human life. When the facts are once exhibited in their proper order and relation, the inferences to be drawn from them hardly require pointing out.

Far, therefore, from the teaching of morals in this sense being unsuited to the public schools, we conceive that it is precisely this that they should most earnestly concern themselves with. The system of state education is upheld on the ground that the stability of the state depends on the character of its citizens, and that this in turn depends on education. We do not now discuss that theory; we only say that a prime inference to be drawn from it is that whatever bears directly on character and conduct should take precedence, in state education, of what only bears indirectly thereon. And we hold not only that morals *can* be taught apart from theology, but that the less moral teaching is complicated with theology, provided only it is delivered with conviction, the better effects it will produce. We want to *know* the reactions that different courses of conduct produce in this world, not to *speculate* as to the reactions they may produce in a world of wholly different constitution. In all probability it may be difficult for a long time to come to obtain a generation of teachers capable of expounding a scientific morality with intelligence, conviction, and enthusiasm; but none the less is it clear that the only morality that can gain a permanent footing in the public schools is one capable of demonstration, one founded on the laws of life.

PSYCHOLOGY AS A SCIENCE.

In looking over the various departments of special scientific study mapped out in the organization of the American Association for the Advancement of Science, one searches in vain for any recognition of psychology. In the various sections provided for by the Constitu-

tion, the nearest approach to the psychological domain is found in biology and anthropology. We suspect that no student of mind would be content to allow his chosen science to be treated as an appendage to either of these sections, and yet it appears that he must find its place in one of them, if at all.

It can hardly be that this omission occurs because there are so few who are engaged in psychological study. The editor of "Mind" asserts that, of the contributions submitted for publication in that journal, the American articles indicate in our country a very deep and widely diffused interest in that subject, and have specially attracted his attention both for their quantity and for their excellence. American psychological students have recently demonstrated the existence of the temperature-sense as an independent sensibility. Every college has its department of mental science, and there are many well-known workers in this field. Even if such were not the case, still it may reasonably be supposed that one of the objects of the Association is to encourage labor in neglected branches of science by calling attention to them.

The probabilities are, that the old prejudice against "metaphysics" has survived and causes a reluctance to concede any scientific value to psychology. If this be so, it is certain that the feeling in question ought to be abated by a more just estimate. Time was, of course, when psychology meant speculation; but that time has passed away. Psychology to-day has just as definite a scientific character as has biology. Its study is pursued by strictly scientific methods, and by scientific tests its results are measured. True, indeed, this can not be said of all study that calls itself psychological. But then we have plenty of people terming themselves biologists whose methods and purposes are absolutely empirical. Yet there is a science of biology, and in as high a degree there is also a science of psychology, notwithstanding that there are sometimes empirics concerned in both. The latter has its distinct province, its subdivisions into various important departments with specialists in each; and the substantial additions it is constantly making to human knowledge are abundant enough and of sufficient consequence to entitle it, upon the most modest claims, to an honorable position in the circle of the sciences.

We think the American Association at its coming meeting would act wisely in creating a Psychological Section. Even if there be danger that psychology will sometimes run mad from the poison of metaphysical virus, it is well to reflect upon the truth in John Stuart Mill's remark to the effect that without philosophy we can never be really sure that we know anything.

LITERARY NOTICES.

THE ELEMENTS OF ECONOMICS. By H. D. MACLEOD. Vol II, Part I. New York: D. Appleton & Co. 1886. Pp. 376. Price, $1.75.

THIS is a work that departs widely from current economic doctrine. It is an attempt to reconstitute the science solely upon the basis of the law of supply and demand; and, while this may not at first sight seem a very novel proceeding, the results arrived at certainly differ greatly from those commonly taught. The main thesis to the support of which the author brings much ingenuity of argument is that debt or credit is wealth—not in the sense of being a representative of existing wealth, but a distinct addition thereto, and he holds that the too narrow conception of wealth heretofore held by economists has incapacitated them for dealing with the complicated phenomena of modern credit in any satisfactory way. The conclusion that debt or credit is wealth is a direct consequence of his definition of wealth, which he maintains is anything which is exchangeable whose value can be measured in money.

All property consists of rights, whether to material things, one's own labor, or to a participation in the future profits of any

undertaking. A debt as an exchangeable commodity is simply a "right of action." It lies wholly in the future; but it has a present value; and when put in the form of a negotiable instrument can be bought and sold equally with any material commodity. As instruments of credit can be multiplied indefinitely beyond existing material property, they form a distinct addition to existing wealth.

All wealth being produced in order to be exchanged, the problem of economics, according to our author, is to determine the conditions in conformity with which exchanges take place—that is the law of value. In arriving at this he sweeps aside the doctrine that value is due to labor, or is determined by the cost of production. Cost of production is simply the lower limit below which the value of anything can not stay for any considerable time and the thing continue to be produced. The labor embodied in anything bears no definite relation to its value. Many valuable things have no labor whatever associated with them. The sole cause of value, the author contends, is demand. If anything will exchange for something else, it has value; if it can not be exchanged, it has no value. Value, therefore, is not something which resides in a thing, but is given to it by the consumer. The same thing may consequently have very different values in different times and places. Value always being a ratio—a relation between two things—it follows that intrinsic value is a contradiction. The search for an invariable standard of value which is based upon the conception of intrinsic value is a wholly futile proceeding. Money may, indeed, be a measure of value—that is, the medium in terms of which all other values are reckoned—and this is quite sufficient. An invariable standard of value is not only unobtainable, but would be wholly useless if it were obtainable.

With these two postulates, that anything is wealth which can be bought and sold, and that the value of anything depends solely upon the relation between supply and demand, the author undertakes a consideration of the various problems of the science. We can not here undertake to follow him in his exposition, but will simply indicate the scope of his inquiry. The first volume, which was published some five years ago, is mainly devoted to establishing his propositions with regard to wealth and value. As if afraid to get too far away from the economists of acknowledged position, he fortifies himself at every step by numerous quotations from their works, showing that they have at one time or another admitted the validity of his own position. In the present volume, which closes his discussion of "Pure Economics," he considers the relation of labor to value, and the conditions affecting the wages of labor. He scouts the wage-fund theory, and contends, in agreement with various other economical writers, that the wages of labor come out of production; but he has nothing hopeful to offer to wage-workers, simply contenting himself with admonishing them to keep their numbers down.

Upon the subject of the rent of land, the author is quite at variance with the most authoritative economic teaching. He has small respect for the Ricardian theory, and maintains that Ricardo has uniformly inverted cause and effect. He does not see that land offers any special feature that takes it out of the realm of other economic quantities. The owner of a piece of land has the right to the successive crops forever, and its purchase-price is simply the summation of the present value of the successive future returns. The rent of land is simply the interest on the purchase-price.

Rights, or incorporeal wealth, the foreign exchanges, the currency, Law's theory of paper money, and a consideration of the legislation affecting the Bank of England, make up the remainder of the volume.

PROCEEDINGS OF THE COLORADO SCIENTIFIC SOCIETY. Vol. II. Part I. 1885. Denver, Colorado. Pp. 36. Price, 50 cents.

THE most important paper in the report is the address of the retiring president, Richard Pearce, on the growth and work of the society, particularly as they are related to the interests of Colorado. It claims that the science of mineralogy has been especially benefited by the society's labors, through which a great many additions have been made to the list of strictly Western minerals. The most important achievement is the discovery of three distinct new minerals.

PSYCHOLOGY: THE COGNITIVE POWERS. By JAMES MCCOSH, D. D., LL. D., Litt. D. New York: Charles Scribner's Sons. 1886. Pp. 245. Price, $1.50.

THE author says in his preface: "For the last thirty-four years I have been teaching psychology. . . . From year to year I have been improving my course, and I claim to have advanced with the times." No one acquainted with Dr. McCosh's earlier treatises would deny upon examining this one that he has "advanced." The trouble is, he has not advanced fast enough nor far enough—"the times" have distanced him in the race; and, after we have given all due credit, we have to confess to ourselves that this latest work leaves us with the consciousness of a good deal to be desired. We suppose the author would maintain that his account of the cognitive powers is scientific. But at the very outset a suspicion is cast upon its scientific character by the opening sentence: "Psychology is the science of the soul. . . . By *soul* is meant that self of which every one is conscious." Now, we fear Dr. McCosh's Scotch fondness for theological battles has interfered in this case with that simplicity of truth which the faithful expositor of science ought to exhibit in his statements. The implications of the word *soul* extend much further than is indicated. Dr. Reid expressed them when he said, "It is a primitive belief that the thinking principle is something different from the bodily organism, and, when we wish to signalize its peculiar nature and destiny, we call it *soul* or *spirit*." In a word, *soul* has reference distinctively to mind as immortal or as capable of existing independently of the present bodily organism. This meaning is not openly declared by Dr. McCosh, but by the use of the term an argument is quietly instilled into the mind of the reader. President Porter, who also calls psychology the "science of the soul," is much more frank in his exposition. But, certainly, inasmuch as the immortality of the soul is something which we all hope psychology will demonstrate as a result of the examination of mental processes and powers, would it not be more satisfactory to every one and add to the value of our researches if we did not start out with assuming the point to be proved? This same disposition to study mind for the purpose of substantiating some theory crops out all too noticeably throughout the whole work. To refer again to the preface, we are informed that idealism and agnosticism are to be exploded, and, as we go on, the claws of polemical metaphysics protrude far too often for the scientific value of the book. The writer is fond of "laying down" positions which "deliver us" from great philosophical errors of the day. No doubt they do, but the warrant for laying them down is unfortunately not always so plain as the eagerness to establish them.

This is a very serious defect. Besides, although we find much to approve in particular statements, the latest, the clearest, the best results of psychological study are not brought out nor recognized as they should be. The same cloudiness and contradiction which perplex the student in the "Intuitions of the Mind" annoy us here. The classification of mental powers and their modes of exercise is cumbrous and antiquated. It is not so good as that of Sir William Hamilton, and is inferior to that of President Porter. We have, for example, no less than "six different capacities" of the representative powers, among which is placed association. But association is as much concerned with presentative knowledge as it is with representative; and even the old divisions of reproductive and productive imagination or memory and imagination would be quite sufficient to cover all not included under association. Moreover, it is very confusing to find afterward as distinct powers the comparative, including the apprehension of relations and discursive operations, as if the associative and representative powers were not adequate to explain all these mental acts. Moreover, under the "relations" classified, we notice identity and difference, and then resemblance. Obviously, identity is only complete agreement, and resemblance less complete; while it may be said of the whole catalogue of relations mentioned, that it would certainly be greatly simplified by almost every authority in psychological and logical science.

The treatment of the discursive operations is exceedingly meager, but doubtless the author thinks this should be left for logic. The exposition of sense-perception is

in the main good. Here the work is least anachronistic. We are glad to see that Dr. McCosh enunciates clearly that sensation and perception go together, there being no sensation without perception. We wish he had also made evident the fact that there can be no perception without representation. There is some useful information in the finer print notes, and the student ought not to overlook it. This last is true of other parts of the book as well.

However much fault we may be disposed to find with this treatise, considered as a scientific account of the cognitive powers, we think no one can deny that it contains much valuable moral didactic. The dangers of novel-reading are vividly portrayed; "some even of our Sabbath-school stories" tend "to dissipate and weaken the mind." Attention is called to the fact that "those who would allure the thoughtless know well how to set off sin and folly by theatrical accompaniments, by the setting of cut flowers which look pretty by night, but which are faded on the morrow"; and warnings are uttered in great profusion against evil habits of all sorts. This is, of course, very excellent. It makes the book a safe one to put in the hands of youth. It also adds to its merit that we can unreservedly say, as the critic whom Leslie Stephen quotes in the preface to his "Science of Ethics" remarked of Dr. Watts's sermons, that there is nothing in President McCosh's work "calculated to call a blush to the cheek of modesty."

MANUAL TRAINING. By CHARLES H. HAM. New York: Harper & Brothers. Pp. 403, with Illustrations.

MR. HAM is evidently an enthusiastic believer in the full efficacy and competency of manual training—habitude in the use of tools and the execution of designs—to work out the solution of social and industrial problems. He regards tools as the great civilizing agency of the world; believes that "it is through the arts alone that all branches of learning find expression, and touch human life"; and accepts as the true definition of education "the development of all the powers of man to the culminating point of action; and this power in the concrete—the power to do some useful thing for man—this must be the last analysis of educational truth." A study of the methods of the manual training department of Washington University at St. Louis brought him to the conclusion that the philosopher's stone in education had been discovered there. He wrote constantly on the subject for three years, and in the mean time the Chicago Manual Training-School was established. The account of this institution and its operations forms the basis of this work, which includes also a kind of general survey of the whole theory and history of education from the point of view which the author has described himself as occupying. In the book are included descriptions of the various laboratory class processes of the Chicago school during the course of three years; arguments to prove that tool practice is highly promotive of intellectual growth, and in a still higher degree of the upbuilding of character; a sketch of the historical period, in order to show that the decay of civilization and the destruction of social organisms have resulted directly from defects in methods of education; and a brief sketch of the history of manual training as an educational force. The disposition to exalt the "new education," which is one of the most striking characteristics of this book, is deserving of all honor. That education, most men will admit, has been too much neglected in our times, and is unappreciated and discouraged to-day by the very men who ought to be most interested in upholding it—the artisans themselves, as represented by their trades-unions. It is well for it to have an advocate whose heart is full of it. Another disposition, and a still more striking characteristic of the book, is not so commendable: we mean the disposition to decry the old education and its fruits. To say that the value to man of the services of such a statesman as Mr. Gladstone—who is undoubtedly one of the best fruits of the old system of education—is relatively unimportant, while that of Mr. Bessemer's services is "enormous, incalculable," is rank nonsense; and this we may say without underrating the benefit mankind have derived from Mr. Bessemer's invention. The old education, which has given us Mr. Gladstone and the statesmen, and numerous artists and illustrious invent-

ors, and made Mr. Bessemer possible, has contributed a large part toward making the world what it is. That it is not perfect, and has from time to time to be supplemented to meet the constantly developing wants of society, does not detract from its real value, or from the fact that whatever is brought in in addition to it is closely connected with it, and largely dependent upon it for the power to perfect itself. It was supplemented in the middle ages by something very like the manual training-schools, in the shape of the guilds, and the systems of apprenticeship and journeymen; and it is the workmen, who have deliberately cast these systems away, and are decrying all distinctions founded on excellence, and not the advocates of the old education, that have made the new training-schools necessary.

CONTRIBUTIONS TO THE TERTIARY GEOLOGY AND PALEONTOLOGY OF THE UNITED STATES. By ANGELO HEILPRIN, Professor of Invertebrate Paleontology at the Academy of Natural Sciences of Philadelphia. Philadelphia: Published by the Author. 1884. Pp. 117.

PROFESSOR HEILPRIN has, in the present volume, made a valuable addition to the literature on this subject.

Besides offering a general systematic review and analysis of the formation taken as a whole, a concise statement is given of the geology of the tertiary period in all of those States of the Atlantic and Gulf border where the formation has been determined; each of these States is separately considered.

The second division of the book treats of the relative ages and classification of the post-eocene tertiary deposits of the Atlantic slope; and contains carefully prepared faunal lists of Maryland, Virginia, and North and South Carolina.

The other divisions of the volume relate respectively to the stratigraphical evidence afforded by the tertiary fossils of the peninsula of Maryland; to the occurrence of nummulitic deposits in Florida, and the association of nummulites with a fresh-water fauna; a comparison of the tertiary mollusca of the Southeastern United States and Western Europe in relation to the determination of identical forms; and to the age of the Tejon rocks of California, and the occurrence of ammonitic remains in tertiary deposits. A map accompanies the volume.

The whole work bears the mark of careful study and research, and will undoubtedly greatly assist the labor of future workers in this field.

ANNUAL ADDRESS. By C. V. RILEY, as President of the Entomological Society of Washington for 1884. Pp. 10.

THE society had just closed its first year when this address was delivered (March 18, 1885). The address notices some of the more striking entomological events of the year, and brings forward some general observations that are suggestive. With reference to the Entomological Division of the Agricultural Department, of which Dr. Riley is the head, no one more fully than himself appreciates how far it falls short of his own ideal and of the necessities of the country, or "how difficult it is to build up to that ideal under the unfortunate political unscientific atmosphere that pervades the department. . . . It was to get away from official surroundings, away from the work of the United States entomologist, that the members of the division decided to join in the organization of this society. It was still more to get acquainted with those of kindred tastes outside the department, in Baltimore and elsewhere, as well as in Washington, and to cultivate social intercourse and interchange of views and experience." The various branches of the science are well represented in the society and in the various collections in Washington.

THE CLIMATIC TREATMENT OF DISEASE: WESTERN NORTH CAROLINA AS A HEALTH RESORT. By HENRY O. MARCY. Pp. 24.

THE former subject mentioned in the title is considered in the first fourteen pages of this pamphlet. Concerning the second subject, we have a description of the triangular region between the Blue Ridge and the Smoky Mountains of Northern North Carolina, where, within an area of fifty miles, there are twenty peaks over six thousand feet high; nine tenths of the entire district is an unbroken, primeval forest of the largest growth, chiefly of decidu-

ous trees; and not a lake or a swamp is to be found in the entire region. The water is pure and abundant, and sulphur and iron springs are not rare. "One great benefit to invalids of all classes lies in the purity of the air, which the extraordinary forest-growth does much to render equable in temperature and moisture. Dust is unknown. The electrical phenomena of the summer storms are exceptional. . . . Notwithstanding the utter disregard of the laws of health by the inhabitants, they are a long-lived race of people."

KANT'S ETHICS: A CRITICAL EXPOSITION. By NOAH PORTER. Chicago: S. C. Griggs & Co. Pp. 249. Price, $1.25.

THIS volume is the fifth of Griggs's series of Philosophical Classics. President Porter enforces the description implied in the title that his treatise is both expository and critical. It proposes first to interpret and then to criticise the principal features of Kant's ethical system, and the one in order to effect the other. In performing his work, the author has thought it best to state the theory very largely in Kant's own language, with such comments as might be required to make it intelligible; and he has done this, both in order that he might be entirely just to Kant himself, and that he might aid the unpracticed student in the task of interpreting the German philosopher. Besides a brief general introduction, President Porter gives a summary or condensed review of the distinctive positions taken by Kant upon the most important topics as compared with those of other writers, and strictures upon Kant by a few German critics.

THE ECONOMICAL FACT-BOOK AND FREE-TRADER'S GUIDE. Edited by R. R. BOWKER. New York: The New York Free-Trade Club. Pp. 151.

THIS volume is in the main a statement of facts, given in their most concise shape, without varnish, with some statements of opinion in which both sides are represented for guidance in making up the mind on the tariff issue. It is prepared for the furtherance of free-trade principles, which the editor assumes in the introduction, are supported by the facts of history and of present experience, as well as by the principles of economics. In it are a short history of the tariff, quotations from American leaders and party utterances on revenue reform, "Protectionist Points and Free-Trade Facts," and valuable tables. Free trade is admitted to have several shades of meaning. The free-trade cause is said to include the great body of men who oppose the principle of trade-restriction called protection, and whose common aim is to get this "mischievous element" out of the tariff and confine taxes to the support of the Government. This implies a "tariff for revenue only. . . . The immediate steps to this end are the freeing of crude materials from duty at the bottom, and the reduction of excessive duties at the top. All shades of revenue reformers unite in these steps, and are willing that their success should be the test of further advances in freeing trade."

MUNICIPAL ADMINISTRATION. By ROBERT MATHEWS. Rochester, N. Y. Pp. 16.

THIS pamphlet embodies the substance of an address delivered before the Fortnightly Club of Rochester. After reviewing the whole subject, the author reaches the conclusions that the misgovernment of cities is due to the imperfections of human nature, imperfections of our election machinery, and mistaken ideas about the proper functions of city government. The reforms needed are proportional representation, business administration, and that elevation of humanity which is both a cause and a consequence of good government.

BULLETIN OF THE UNITED STATES GEOLOGICAL SURVEY. Nos. 15 to 26. Washington: Government Printing-Office.

No. 15 is "On the Mesozoic and Cenozoic Fauna of California," by Dr. C. A. White. No. 16 is "On the Higher Devonian Fauna of Ontario County, New York," by J. M. Clarke. No. 17 is "On the Development of Crystallization in the Igneous Rocks of Washoe, Nevada," etc., by Arnold Hague and J. P. Iddings. No. 18 is "On Marine Eocene, Fresh-Water Miocene, and other Fossil Mollusca of Western North America," by Dr. C. A. White. No. 19 is "Notes on the Stratigraphy of California," by George F. Becker. No. 20 is "Contribu-

tions to the Mineralogy of the Rocky Mountains," by Whitman Cross and W. F. Hillebrand. No. 21 is "The Lignites of the Grand Sioux Reservation," and a "Report on the Region between the Grand and Moreau Rivers, Dakota," by Bailey Willis. No. 22 is "On New Cretaceous Fossils from California," by Charles A. White. No. 23 is "Observations on the Junction between the Eastern Sandstone and the Keweenaw Series on Keweenaw Point," by E. D. Irving and T. C. Chamberlin. These constitute Volume III of the "Bulletin," a volume of 498 pages, with many plates, and are sold separately at five cents each, except No. 20, the price of which is ten cents, and No. 23, fifteen cents. No. 24, which will be the beginning of Volume IV, is a "List of Marine Mollusca, comprising the Quaternary Fossils and Recent Forms from American Localities between Cape Hatteras and Cape Roque, including the Bermudas," by W. H. Dall, twenty-five cents. No. 25 is "On the Present Technical Condition of the Steel Industry in the United States," by Phineas Barnes, ten cents. No. 26 is "On Copper-Smelting," by H. M. Howe, ten cents.

AN INTRODUCTION TO THE STUDY OF THE CONSTITUTIONAL AND POLITICAL HISTORY OF THE STATES. By FRANKLIN JAMESON. Pp. 29. A PURITAN COLONY IN MARYLAND. By DANIEL R. RANDALL. Pp. 47. Baltimore: N. Murray. Price, 50 cents each.

THESE essays are, respectively, Nos. 5 and 6 of the fourth series of the "Johns Hopkins University Studies in Historical and Political Science." Mr. Jameson's essay is an endeavor to illustrate the importance of the study of local political movements, from those of the town and township to those of the State, in their bearing on the constitutional development of State and national governments. In it, he notices the tendency, which is not a good one, to insert provisions respecting details, mere temporary elements, into constitutions, as tending to impair the reverence with which those charters ought to be regarded, to lower their authority, and to introduce into our governments a most undesirable instability. Mr. Randall's study relates to the history and influence of a colony of Puritans—whose first leader, the Rev. Alexander Whittaker, performed the baptismal and marriage ceremonies for Pocahontas—that was planted at Norfolk, Virginia, in 1611, and removed thence on account of persecution, and settled at the mouth of the Severn River, in Maryland, in 1649. It formed the nucleus of the democratic party in Maryland. A parallel is drawn between its history and that of Providence Plantations, in Rhode Island: "As Roger Williams was driven from the mother Commonwealth of Massachusetts for holding heretical doctrine, so Durand, the Puritan elder, was expelled from the mother colony in Virginia, to seek a new home for religious toleration. Both leaders came to lands unoccupied, save by Indians, and invited their brethren to follow. Both called the land to which they came through divine guidance, 'Providence.'"

PROCEEDINGS OF THE DAVENPORT ACADEMY OF SCIENCES. W. H. Pratt, Recording Secretary. Vol. IV. 1882–1884. Davenport, Iowa. Pp. 358, with Six Plates. Price, paper, $4.

THE present volume contains a brief synopsis of the proceedings of the Academy for the years 1882, 1883, and 1884, in which the memoirs, chiefly on subjects of botany, fossils, and archæology, hold the prominent place, with the contributions to the museum during 1879, 1880, and 1881. Among the memoirs are several of value to the flora of Iowa, and some of value to botany, including a few carefully prepared special papers. Concerning fossils, are some descriptions of new crinoids and blastoids. In archæology, Dr. W. J. Hoffman contributes "Remarks on Aboriginal Art in California and Queen Charlotte's Island"; Mr. William H. Holmes a monograph on "Ancient Pottery in the Mississippi Valley," the fruit of studies in the collections of the Academy's museum; and Mr. C. E. Harrison and Dr. C. H. Preston accounts of mound explorations. Mr. Putnam's paper on "Elephant Pipes and Inscribed Tablets," concerning which subjects Mr. Powell, of the United States Geological Survey, has controverted the views held and put forward by the Davenport investigators, is published as a supplement, to place on permanent record the position and arguments of the latter. The publication of Volume V of the

"Proceedings" has been begun, and four papers intended for it are in the hands of the printers. Notice is taken of the fact that the indebtedness on the building of the Academy has been paid, and the formation of a permanent endowment fund has been begun. Two chapters of the Agassiz Association of America for the study of natural history, and a "Humboldt Society," which seeks to unite philosophical speculations with scientific investigations, have been formed in Davenport, and hold their meetings in the rooms of the Academy. It is observed that the membership of these organizations is made up wholly of young men and women, largely students in the public schools of the city. These facts, and everything connected with this volume, speak well for the earnest interest that prevails at Davenport in the study of science.

On Small Differences of Sensation. By C. S. Peirce and J. Jastrow. Pp. 11.

A record of experiments to determine the point at which differences in the intensities of nerve excitations cease to be perceptible. Among the points brought out is the probability that we gather what is passing in one another's minds in large measure from sensations so faint that we are not fairly aware of having them, and can give no account of how we reach our conclusions about such matters. The insight of women as well as certain "telepathic" phenomena may be explained in this way.

A Treatise on the Diseases of the Nervous System. By William A. Hammond, M. D. Eighth edition; with Corrections and Additions. New York: D. Appleton & Co. Pp. 945. Price, $5.

It would be hardly possible to give a better evidence of the merit of this work than is afforded by the appearance of this, the eighth edition, testifying that during the fifteen years it has been before the public it has been tried and found not wanting. The first edition was published in 1871, as resting to a great extent on the author's own experience. Its declared purpose was to be a treatise which, without being superficial, should be concise and explicit, and, without claiming to be exhaustive, should be sufficiently complete for the instruction and guidance of those who might consult it. The sixth edition, in 1876, was entirely remodeled and greatly enlarged. The seventh edition received extensive additions, and was translated into Italian under the supervision of Professor Borrelli, of Naples. The opportunity given by the appearance of this eighth edition has been improved to revise the work thoroughly, make several changes, and add a section on "Certain Obscure Diseases of the Nervous System."

A Critical History of the Sabbath and the Sunday in the Christian Church. By A. H. Lewis, D. D. Alfred Centre, New York: The American Sabbath Tract Society. Pp. 583. Price, $1.25.

Dr. Lewis is a prominent minister of the Seventh-Day Baptist Church, which teaches, according to his own statement, "that the law of God as contained in the Decalogue is eternal and universal, both as to its letter and its spirit; therefore, the seventh day is the only Sabbath; that under the gospel it should be observed with Christian freedom and not Judaic strictness, but that the change which Christ taught was a change in the spirit and manner of the observance, and not in the day to be observed." The argument pursued in this work is exclusively historical, and is intended to show that no authority worthy of respect exists or ever existed for the change that has been made in the day to be observed—from the seventh day to the first. The evidence, which is intended to be full and continuous from the gospels down, is given in the exact words of the texts cited, and in all the words that bear on the subject, and not in paraphrases or abstracts, so that, if any mistake be made in its import, it shall not be the author's fault. In this way Dr. Lewis attempts to show that no change is authorized in the Gospels, or in the words of any of the apostles; that the change was not made or recognized in the first two centuries; that the first signs of it appear in the days of Constantine, when the seventh day was still observed as the Sabbath, and Sunday, being the day of the resurrection, was celebrated in addition, as a religious festival; that Sunday observance gradually grew at the expense of the seventh-day observance, particularly under the auspices of the Latin Church, and under the

impulse of a spirit of concession to paganism and worldliness; that the seventh-day Sabbath was preserved much longer in the Eastern churches; and that the present decay of Sunday is a logical outcome of the disregard of the sanctity of the original, divinely instituted, but never divinely changed Sabbath. Dr. Lewis believes that the general results of civil legislation respecting the Sabbath—like those of legislation on all religious questions—have been evil. "Take the question," he says, "out of politics, out of the realm of caucussing and plotting, and let the Church settle it as it would any other religious issue. For . . . if the day ought to be kept by divine authority, the civil law can not strengthen that authority, and by a false application it may weaken and destroy it; and if he who does not rest out of regard to the Lord, does not truly Sabbatize, his resting is only an empty form or a blasphemous pretense. Under the working of the civil law as the prominent element of authority, Sunday has tended and must tend to holidayism; and, with the masses, toward debauchery."

MEDICINE OF THE FUTURE. By AUSTIN FLINT (Senior), M. D. New York: D. Appleton & Co. Pp. 37, with Portrait. Price, $1.

THE manuscript of this paper, which was the address the author had intended to read, by special appointment, before the British Medical Association at its meeting in 1886, was found after Dr. Flint's death among his papers. Considering the progress which has been made in medicine during the past fifty years, the author anticipates as great, or greater, in store for the next half-century, and indicates the lines along which, in his view, it may be expected to be realized.

LIFE, ITS NATURE, ORIGIN, DEVELOPMENT, AND THE PSYCHICAL RELATED TO THE PHYSICAL. By SALEM WILDER. Boston: Rockwell & Churchill. Pp. 350. Price, $1.50.

THE author, whose business is an agency for the sale of goods, has been interested in questions indicated by the title of his book, and is not satisfied with the manner in which the physical philosophers of the day try to answer them. He has, therefore, inquired what science and scientific men teach respecting them, and presents the results of his investigation in the first part of the book. The second part is devoted mainly to ethical questions.

THE OLDEN TIME SERIES. No. 1, Curiosities of the Lottery, pp. 73; No. 2, Days of the Spinning-Wheel, pp. 99; No. 3, New England Sunday, pp. 65. Boston: Ticknor & Co. Price, 50 cents each.

A SERIES of collections of advertisements, items, and articles illustrating, by contemporary representations, the usages and the ways of thought, as well as the economical condition, of the people of the "olden time" in New England, culled chiefly from old newspapers of Boston and Salem, Massachusetts, and arranged, with brief comments, by Henry M. Brooks. The volumes are adapted to gratify a growing taste, and are of a size convenient for the pocket. The matter of numbers one and three is all closely related to the subjects expressed in the titles; that of number two takes a range beyond the spinning-wheel, and is varied.

LESSONS IN QUALITATIVE CHEMICAL ANALYSIS. By Dr. F. BEILSTEIN. Arranged, on the Basis of the fifth German edition, by Charles O. Curtman, M. D. St. Louis, Mo.: Druggist Publishing Co. Pp. 200.

THIS is the second edition of a translation of Dr. Beilstein's "Anleitung," a popular German text-book on chemical analysis. Dr. Curtman has, however, considerably enlarged on the original, and made numerous additions. The opening chapter is given to chemical manipulations: it contains suggestions on the management of the blow-pipe, the handling of glass-tubing, the working with corks, etc. These directions are supplemented by a series of examples for practice in the qualitative analysis of inorganic substances. Directions for the systematic examination of substances containing one base and one acid come next in order, and these again are followed by instructions for a systematic course of qualitative analysis.

The remaining chapters are devoted to examples for practice on the analysis of organic substances, to volumetric analysis, to the examination of drinking-water, the analysis of urine, urinary sediments, and

calculi. A colored plate of flame and absorption spectra and a plate illustrating various urinary sediments, are added; moreover, some illustrations are given in the text.

This book is primarily intended to be used as a class-book in the laboratories of medical and pharmaceutical schools, but it is also well adapted for self-instruction in the principles of chemical analysis.

WATTS'S "MANUAL OF CHEMISTRY." (Based on Fownes's "Manual)." Vol. II. Organic Chemistry. Second edition. By Professor WILLIAM A. TILDEN. Philadelphia: P. Blakiston, Son & Co. 1886. Pp. 662.

THE general favor which is accorded to Mr Watts's editions of Fownes's "Manual of Chemistry," shows how well adapted is the work to meet the wants of teachers and students.

Professor Tilden, of Birmingham, the editor of this issue, has closely adhered to the plan of his predecessor, and has mainly endeavored to make the corrections and additions rendered necessary by the progress and development of the science. The nomenclature has been made as uniform as possible, and has been brought into accordance with the system adopted by the London Chemical Society.

The introduction treats of the synthesis of organic compounds from inorganic materials, of ultimate analysis, the classification of organic compounds, their physical properties, and the decompositions and transformations of these bodies.

The chief division of the carbon compounds is, of course, into the fatty and the aromatic groups, or, as they are styled, into methane-derivatives and benzene-derivatives.

In the subdivisions of these groups the organic compounds are classified according to their chemical structure and functions; the compounds in each group are arranged in homologous series, and the several groups are separately considered. While the editor has tried to avoid swelling the volume to too large a size, he has aimed to give in it an account of, or at least a reference to, all carbon compounds which can fairly be regarded as having any considerable theoretical interest or practical importance.

THE STATE CONTROL OF MEDICAL EDUCATION AND PRACTICE (IN THE NEGATIVE). By ROMAINE J. CURTISS, M. D. Joliet, Illinois. Pp. 32.

DR. CURTISS writes in the spirit of a man who considers himself engaged in a controversy. His situation, in fact, invites vigor on the part of a disputant who speaks from his side, for he is a physician in a State where State control is exercised quite fully. Along with many expressions which might be softened without diminishing their argumentative strength, we find points presented that apply with much force in favor of the negative side of the question; among them the one embodied in the opening paragraph: "The modern method of throwing physic to the dogs seems to be to put the matter of medical education and practice under the control of the State; which means, of course, nothing more or less than making medical education and practice a factor of State politics. This method assumes that politics is a better criterion of the standard of medical education than any educational test, or any life-test, and also assumes that colleges are not qualified, by reason of natural favoritism, to judge of the merit of their work." This description may not now apply, as a fact, in any State, but, the political factor once introduced, there is danger, as the political machines have been running, that the ultimate result may be fitted to it.

ON THE DEVELOPMENT OF VIVIPAROUS OSSEOUS FISHES, AND OF THE ATLANTIC SALMON. By JOHN A. RYDER. Washington: Government Printing-Office. Pp. 36, with Seven Plates.

THE former paper is intended to give a summary of our knowledge respecting the best known of the truly viviparous osseous fishes characterized by an intra-follicular or intra-ovarian development. The second paper is based on the investigation of recently hatched embryos of the landlocked salmon.

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nest Renan à propos de l'Inscription Phénicienne Apocryphe. (Letter to M. Ernest Renan, respecting the Apocryphal Phœnician Inscription.) Pp. 39 Rio de Janeiro.

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James, Professor Joseph F. The Geology of Cincinnati, and other Papers. Pp. 16.

State Board of Health of Illinois. Seventh Annual Report. Springfield, Ill. Pp. 613.

Hunt, A. O. Dental Directory of the Northwestern States and Territories. Iowa City, Iowa. Pp. 57.

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Putnam, F. W. Report of the Curator of the Peabody Museum of American Archæology and Ethnology. Pp. 25. Central American Jades. Pp. 8. Lectures on American Archæology (Programme). Pp. 6. Cambridge, Mass.

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Patton, A. A., New York. Responsibility of Vocal Teachers as Voice-Builders. Pp. 20.

Shufeldt, R. W. A Navajo Skull. Pp. 4, with Plates. Remarks of Professor Sir William Turner on this Paper. Pp. 2. Osteology of Conurus Carolinensis. Pp. 18, with Plates.

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Kneeland, Samuel. The Subsidence Theory of Earthquakes. Pp. 8.

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POPULAR MISCELLANY.

Advantages of the Lick Observatory.—Mr. David P. Todd, in a pamphlet descriptive of the Lick Observatory, Mount Hamilton, California, mentions as among the advantages of its peculiar situation that the steadiness of the atmosphere at that height permits the regular employment of telescopic eyepieces which magnify two or three times as much as the instruments in ordinary use. "It is thus not unreasonable to expect that a few nights in the course of each observing year may be found when the maximum magnifying power—about thirty-five hundred diameters—may be advantageously employed on the great telescope. The theoretical distance of the moon would then become about sixty miles, but the corresponding ideal conditions of perfect vision can never be obtained." The observer might, however, expect to see the moon

much the same as he would without the telescope if it were only a hundred miles away. "The fact of mere elevation (less than a mile) above the sea-level," Mr. Todd observes, "will not, as is often supposed, greatly increase the apparent light of celestial objects, as the stars will appear to be only a small fraction of a magnitude brighter on the mountain than at the sea-level. But—what is incomparably more important—the gain in steadiness of the atmosphere has been much greater than any one expected at the onset, and will enable the astronomer not only to make good use of a multitude of clear nights which at less elevated stations are found to be of little value, but also to elevate the grade of all his work to the last degree of precision. Fewer observations will be required for the accurate determinations of the positions of stars. The elevation also makes effectively available a much larger region of sky than can be commanded at other stations in a like latitude, where observations at zenith distances much greater than seventy degrees are usually not worth the making."

Horse-Eating.—The origin of the use of horse-flesh as food is lost in the night of the past. The ancients held the meat in high esteem, and a number of modern peoples use it unhesitatingly. Several Latin and Greek authors mention it. Virgil, in the third book of the "Georgics," speaks of peoples who live on the milk, blood, and meat of their horses. Pliny and Martial refer to the same fact. Pliny says that the ancient Germans killed horses for food, and ate their raw flesh after they had made it tender by carrying it under their legs as they rode. Mixed with mare's milk and blood, this meat formed a royal dish; and the Sarmatian when pressed by hunger never hesitated to procure it for himself by cutting the veins of the animal on which he was riding. The ancient Persians held horse-meat in high esteem for their great feasts. Several Asiatic peoples offer it to guests as a mark of honor. The Tartars regard it as a most delicate meat, preferring the fat and viscera; and Tott, who was sent by the King of France on a mission to the Khan of Tartary, ate excellent smoked horse-sides at his Highness's table. The Yakut bride offers her spouse a cooked horse's head garnished with sauces from the same animal, and this dish constitutes the staple viand of the wedding-feast. The Arabs think as much of horse as of game, and the Chinese use it generally and daily. The South American Indians are passionately fond of horse-meat. The natives of Sumatra have a decided preference for it, particularly if the animal has been well fed on native grains. While horse-flesh was generally eaten among the Germans till they were converted to Christianity, or till the days of Charlemagne, it was regarded with aversion by the early Christians as a relic of idolatry. Gregory III, in the eighth century, advised St. Boniface, Archbishop of Mayence, to order the German clergy to preach against horse-eating as unclean and execrable. This prohibition being ineffective, Pope Zachary I launched a new anathema against the unfaithful "who eat the meat of the horse, hare, and other unclean animals." This crusade was potent over the defectively informed minds of the people of the middle ages, and they, believing the meat to be unwholesome and not fit to eat, abstained from it except in times of extreme scarcity. Nevertheless, it continued to be eaten in particular localities down to a very recent period. The present revival in the use of horse-flesh, concerning which the French papers have had much to say, is the result of a concerted movement among a number of prominent men, the principal object of which was to add to the food resources of the world.

Extremes of Weather in the Past.—Captain W. H. Gardner has examined, for the Alabama Weather Service, the records of the weather—such as exist—from 1701 to 1885, and concludes from them that spells of severe weather of all kinds—extreme heat and cold, violent storms, hurricanes and tornadoes, disastrous floods, and parching droughts—were no more rare in the last century and the earlier part of the present century than now. In 1701 there were recorded at Biloxi, Mississippi, a winter cold that instantly froze water poured into a tumbler, and an August heat that made labor impossible except for two hours in the morning and two in the evening. In the

winter of 1746 water was frozen solid in the houses at Charleston, South Carolina. In 1748 and 1768 the Mississippi River at New Orleans was frozen from thirty to forty feet from the shores. In 1823 skating was possible on all the standing water in and around Mobile. In 1827–'28 the ground in Alabama, Georgia, and South Carolina, was frozen hard from December till March. A flood in the lower Mississippi and a "fearful hurricane" on the Gulf coast were recorded in 1723; another destructive hurricane in 1732; and overflows of the lower Mississippi from January till June, 1735; after which came a long drought, and a lower river than had ever been known. In a hurricane at Dauphin Island, in September, 1740, a four-pounder cannon was moved by the wind to eighteen feet from where it had been lying. Other hurricanes of extreme fury were recorded in October, 1778; August, 1779; August, 1780; and August, 1781. In the last year the Mississippi at New Orleans, the Attakapas, and the Opelousas, were higher than ever before known. The Mississippi at St. Louis was equally high in the flood of 1785 and in July, 1884, and it reached its highest recorded flood in 1844. The flood of the Ohio River in 1832 was not exceeded till 1883. The year 1840 was one of almost continued drought in Alabama and Mississippi, and prayer-meetings were held in view of the apprehended famine. These are only a few of the instances of remarkable phenomena, comparable to those that now attract attention, of which mention is made in Captain Gardner's record.

Coal-Waste as a Manure.—Mr. J. A. Price, of Scranton, Pennsylvania, recommends the use of culm, or coal-waste, in agriculture, by reducing it to dust and applying it to land, to darken the color of the soil, produce porosity, and stimulate plant-life. His opinion that benefits will be derived from this application is confirmed by the experiments he has made. A dark color of the soil is usually associated with fertility, and with reason, for it promotes the absorption of heat and thus makes the soil warmer and prolongs the season of freedom from frost at both ends. Mr. Price's observations of the effect of colors on soils side by side, and otherwise precisely alike, showed that a vigorous existence was maintained on a soil darkened by waste-coal, greatly in excess of that of the adjoining strip which was left in its original condition. So in the quality of porosity, in a soil treated as the author recommends—a blue clay or hard pan taken from an excavation and fertilized with organic manures—it was found that greater porosity as well as improved color was given, and the two sections, treated and untreated, exhibited all the peculiar features of two different soils. The corn upon the culm charged section exhibited a vigor of growth of tap and stay roots and of stalk and ear that surprisingly surpassed that of the other section. This result has been maintained through several plantings; and similar effects were observed with Lima beans. Since coal contains nearly all of the substances requisite for the healthy growth of plants, it is reasonable to suppose that its application will have the effect, as it is gradually decomposed by chemical action, of a positive manure. This supposition has also been confirmed by the experiments. The fertilizing results of this kind begin to reveal themselves in the second year.

The Irrawaddy River.—One of the largest rivers in the world is the Irrawaddy, and it is surrounded with a great mystery as to where is its source. The sea-front of its delta extends over about one hundred and fifty miles, with nine or ten mouths distributed over the space. The average annual discharge is about 521,794,000,000 of cubic yards, very nearly four fifths of that of the Mississippi River. But, while the Mississippi discharges pretty evenly all the year round, the Irrawaddy sends down three fourths of its total in the three months, July, August, and September, or in other words its monthly flood average is more than twice as great as that of the Mississippi. The extreme flood discharge of the Irrawaddy for one day in 1817 was at the rate of nearly 2,000,000 cubic feet per second, while the lowest known discharge occurred in the same year, and may be given in round numbers as 50,000 cubic feet per second, or one fortieth of the flood discharge. The highest flood discharge in one day is fifty per cent

greater than that of the Mississippi, and double that of any river in Europe. The magnitude of the Irrawaddy in its mid-portion causes astonishment to every visitor whose ideas are formed from Western maps. Captain Hanney says, on this subject: "To this point no diminution in the volume of the Irrawaddy was perceptible, from which we may infer that all the principal feeder affluents which pour tributary streams into the Irrawaddy were still farther north, and had not yet been reached." Dr. Griffiths was astonished at the size of the river above Mandalay, and expressed the belief that it is probably "an outlet from some great river which drains an extensive tract of country."

Incidents of Travel in Somauli-Land.—Mr. F. L. James, while traveling in the Somauli country, East Africa, had a serious tax imposed upon him, from a custom of the natives to come to the camp every night to be fed. "They would sit silent on the ground near the camp-fires where our men would be eating, and, though they never asked for food, they always succeeded in getting it given to them." Living among all the Somauli tribes are low-caste tribes: the Midgans, who carry bows and poisoned arrows; the Tomals, workers in iron; and the Ebir, workers in leather charms. An interesting illustration of the faculty of adaptation to the environment is given in the ability of the animals of the country to go without water. The camels on one stretch passed fifteen days without drinking. Sheep are able to go from six to eight days, and the horses of the party several times went three days without water, and without apparent suffering. The arrival of the company at Gesloguby, one of the principal watering-places of the country, created much excitement among the people who were watering their stock. They crowded around the *zariba* in hundreds, "and expressed the greatest amazement at us and our doings. Smoking particularly astonished them, as they thought a pipe was part of our persons, and that the white man kept a fire somewhere inside; and, when one of our party shot a bird, many fell down, while others invoked the protection of Allah." There appears to be a vein of considerable shrewdness among these people. A faction who were opposed to Mr. James's journey found that the British consul-general had received an order from his government after the expedition had started, to stop its departure from the coast; and they made use of their knowledge with an ingenuity which was admirable and gave our travelers much annoyance. A chief of a neighboring nation, the Adone, having received Mr. James, used diplomatic arts which might have become a Gortchakoff to make of him an instrument with which to chastise one of his rivals; and it required all our author's skill to avoid a fight with one or both of the rivals, who, however much they might hate one another, would probably have come together to attack him. Among these Adone, who detest the Somauli, but sell them grain, a man is not looked upon with favor by the women of his tribe till he has killed another, either in a fair fight or by assassination—and assassination is the more common way. This entitles him to paint the boss of his shield red, or to wear a feather in his hair.

The Coming Metal.—It is predicted that aluminum is the coming metal, which is destined to supersede iron. It is the most abundant metal in the earth's crust, and is not exceeded in usefulness. It is the metallic base of mica, feldspar, slate, and clay. It is present in gems, colored blue in the sapphire, green in the emerald, yellow in the topaz, red in the ruby, brown in the emery, and so on to the white, gray, blue, and black of the slates and clays. It has never been found in a pure state, but is known to exist in combination in nearly two hundred different minerals. Corundum and pure emery are very rich in aluminum, which constitutes about fifty-four per cent of their substance. The metal is white, and next to silver in luster; it is as light as chalk, or only one third the weight of iron, or one fourth that of silver; is as malleable as gold, as tenacious as iron, and harder than steel. It is soft when ductility, fibrous when tenacity, and crystalline when hardness is required. It melts at 1,300° Fahr., or at least 600° below the melting-point of iron, and it neither oxidizes in the air nor tarnishes in contact with gases.

New Chemical Elements.—We are indebted to Professor H. Carrington Bolton for the following interesting table of new elements announced since 1877:

Date.	Name.	Source.	Discoverer.
1877....	Davyum	Platinum ores	Sergius Kern.
	Neptunium	Columbite	Hermann.
	Lavœsium	Pyrite	Prat.
	Mosandrum	Samarskite	J. L. Smith.
1878....	"New earths"	Unnamed mineral	Gerland.
	Philippium	Samarskite	Delafontaine.
	Decipium	Samarskite	Delafontaine.
	Ytterbium	Gadolinite	Marignac.
	"X."	Gadolinite	Soret.
1879....	Scandium	Gadolinite	Nilson.
	Norwegium	Gersdorffite	Dahll.
	Samarium	Samarskite	Lecoq de Boisbaudran.
	Uralium	Platinum	Guyard.
	Barcenium	Misapprehension	Editor Wagner's Jahresb.
	Thulium	Gadolinite	Cleve.
	Holmium	Gadolinite	Cleve.
	Columbium	Samarskite	J. L. Smith.
	Rogerium	Samarskite	J. L. Smith.
	Vesbium	Lava	Scacchi.
1880....	Comesium		Kaemmerer.
	Yα and Yβ	Gadolinite	Marignac.
1881....	Actinium	Zinc-ores	Phipson.
1882....	Di β	Gadolinite	Cleve.
1883....	Nameless	Platinum ores	Th. Wilm.
1884....	Idunium	Lead vanadate	Websky.
1885....	Neodymium	Didymium	Welsbach.
	Praseodymium	Didymium	Welsbach.
	Zα	Didymium	Lecoq de Boisbaudran.
	Zβ	Didymium	Lecoq de Boisbaudran.
1886....	Zγ	Terbia	Lecoq de Boisbaudran.
	Germanium	Argyrodite	Winkler.
	Austrium		Linnemann.
	Dysprosium		Lecoq de Boisbaudran.
	Dα	Didymium	Crookes.
	Sβ	Samarskite	Crookes.
	Sδ	Samarskite	Crookes.
	Gα	Gadolinite	Crookes.
	Gγ	Gadolinite	Crookes.
	Gδ	Gadolinite	Crookes.
	Gε	Gadolinite	Crookes.
	Gζ	Gadolinite	Crookes.
	Gη	Gadolinite	Crookes.

Forest Devastation in Japan.—We are permitted to publish the following extract from a private letter from Dr. Heinrich Mayr, who is now in Japan, in the course of a journey round the world: "The disappointment in regard to forests in Japan which I experienced was keen. The Japanese have sent out many students to Europe to study forestry, and have, therefore, the reputation of possessing forests; but nothing of that: the mountains are bare, and the forests burned down, just as they are in the eastern part of the Rocky Mountains. Americans might take a fearful warning in regard to the future prospect of their great West; only the landscape will be still more desolate there, because the land is so divided into small holdings that no forest will be raised. Volcanic eruptions in Japan have buried, a hundred or more years ago, whole forests of "Sooghee," as the Japanese call their species of Sequoia. They are again dug up, and people wonder at their size, and the fine grain of the wood that has become gray, for which enormous sums are paid for cabinet-work; but they are not

practical enough to consider that a careful culture might now cover the mountains again with the same wealth. Perhaps, already, in fifty years, America will have reached the same stage; a few monsters of the forest will be admired, and it will hardly appear credible that the ancestors in their greed and ignorance burned down these priceless treasures for an ephemeral gain, and even where not the slightest gain could be obtained by the wanton destruction. The United States possess still the finest forests of the globe, but in the land of haste, hurry, and greed, anything which can not be turned into money at short notice is destroyed. A little more forethought might benefit not only the future but also the present generations. The climate of Japan is not quite so fine as that of the Western United States, but similar results will follow similar causes. Where the land, freed from forests, is used for agricultural purposes, this forest destruction has a fair excuse; but, where enormous tracts of land are denuded for stock-raising, the very means will defeat the end: stock can not be raised without water, and water will not grow; and, with the disappearance of moisture and forests, hard, tough, varieties of grass will alone cover the mountain-slopes. Japan is the land of inundations, and the effects of forests upon moisture are here most strikingly illustrated. Every thunder-shower sends its whole quantity of water without delay to the rivers and the sea, and within a few hours a mountain-valley has seen a dry channel, a raging torrent, and a little brook occupying the same bed; thousands of acres of good land along these numerous mountain-streams can not be cultivated, because the forests are lacking which would retain the moisture and allow it only gradually to seek the river and ocean. We can not realize enough the consequences of forest destruction. But even arbor-days are only a small remedy; the state alone can own large tracts of successfully cultivated forest-land."

Cultivation of Liquorice.—The State Department has published a collection of consular reports on "The Liquorice-Plant and its Cultivation in Various Countries." In England the plant is cultivated in a sandy, loamy soil, the chief requisite of which is that it should be deep enough to allow the roots to get a good length. A manuring is given the ground at planting, and the crop is gathered in three years and a half afterward. The plants do better, after the first season, in a hot, dry summer. They are not harmed by frost, or afflicted by any worm or parasite. The soil between the rows may be cultivated in other plants during the first two years. The grower plants a fresh crop in the spring of each year, and in the fall of the same year harvests the one of three years and a half's growth. In harvesting, a deep trench is dug, to expose the roots without injuring them, and the whole plant is carefully taken out. Liquorice grows wild in Spain, but requires eight years to reach maturity. Where it has once taken root, it is almost impossible to eradicate it. It exhibits many varieties, in the color of the bark, the proportions of saccharine elements and starch, and woodiness. The ground is pulled at intervals of three, four, or five years, according to circumstances, by digging trenches and pulling all visible stalks as long as possible, until they break. The plant is also found and gathered in Asiatic Turkey, Greece, Italy, Sicily, etc.

Condition of the Oceanic Abysses.—Mr. John Murray, director of the Challenger publications, presents, as a summary of results, that in the abysmal regions which cover one half of the earth's surface, and which are undulating plains from two to five miles beneath the surface of the sea, we have a very uniform set of conditions. The temperature is near the freezing-point of fresh water, and its range does not exceed seven degrees, and is constant all the year round in any locality. Sunlight and plant-life are absent, and, although animals belonging to all the large types are present, there is no great variety of form or abundance of individuals; change of any kind is exceedingly slow. In the more elevated portions of the regions the deposits consist principally of dead shells and skeletons of surface animals; in the more depressed ones, of a red clay mixed with volcanic fragmental matter, the remains of pelagic vertebrates, cosmic dust, and manganese-iron

nodules and zeolitic crystals. It has not yet been possible to recognize the analogues of the deposits now forming in the abysmal regions in the rocks making up the continents, but it is quite otherwise in the areas bordering on the continents. Almost all the matter brought down to the ocean in suspension is deposited in this region, which is that of variety and change, with respect to light, temperature, motion, and biological conditions. It extends from the sea-shore down, it may be, to a depth of three or four miles, and outward horizontally from sixty to three hundred miles, and includes all partially inclosed seas. Plants and animals flourish luxuriantly near the shore, and animals extend in relatively great abundance down to the lower limits of the region. Here we find now in process of formation deposits which will form rocks similar to those making up the great bulk of continental land. Throughout all geological time the deposits formed in this border or transitional area appear to have been pushed, forced, and folded up into dry land, through the secular cooling of the earth and the necessity of the outer crust to accommodate itself to the shrinking solid nucleus within. The changes in the abysmal region, though great, are not comparable with these. The results of many lines of investigation seem to show that in the abysmal regions we have the most permanent areas of the earth's surface.

Rivers underground.—General R. Maclagan, describing the rivers of the Punjab before the Royal Geographical Society, remarks that, when the measure is taken of the water in a river flowing in a wide channel in soft soil, we do not at any time get the whole of it. We measure what is flowing above the bed, but there is more beneath. It sinks down till retained by some impervious stratum, and may become something like a second river flowing under the larger one which we see. It happens sometimes that the whole of a small stream sinks into porous soil and disappears, and, if a retentive stratum which it meets beneath comes out to the surface at a lower part of its course, the filtered water will pour out and become a surface river again, after the ordinary manner of streams. The experiment has been made on the Jumna of shutting off the whole visible river with a weir and turning it into the canals on either bank. A few miles below, the water trickles down into the bed again, and farther below there is a river as before. In most river-beds, like those of the Punjab, when they are left dry at the sides in the low season, water is to be got under the dry bed, as well as under the river, and usually at no great depth. Plenty of water can often be got by scooping a mere hole. The water-supply of Lahore is pumped from wells sunk in the bed of the Ravi. The water which sinks under the beds of these great rivers finds a wide field of hidden usefulness open to it when it gets beneath. Spreading abroad it meets, and helps to make, the great underground lakes and springs on which every country so largely depends. In the rainless tract around the meeting of the rivers in the south of the Punjab, this underground reserve of water is abundant and near the surface. In the distribution of the reserves there are great variations, according to the varying extent, form, and positions of the dividing walls of impermeable soil. The admission of water to new canals is commonly followed by the rise of the water-level in wells within a certain distance on either side. Like the Mississippi, the Indus has in a part of its course raised its bed by the deposition of silt, so that for nearly four hundred miles it runs on an embankment made by itself, with long gentle slopes on both sides down to the general low level of the country. As along the Mississippi, the country is protected by dikes, and danger is apprehended in flood-times from crevasses.

Advantages of Sea-Voyages.—A medical writer in "Chambers's Journal" makes a warm recommendation of sea-voyages as a means of restoring health and strength. Among the chief advantages of a voyage are the perfect rest and quiet it secures. It is sure to take the passenger and keep him for a time out of the reach of all home annoyances and home drudgeries, and in many cases out of mind of them. He "has only to eat, sleep, and live. The strain of life is withdrawn. The wheels of existence move easily and with lessened friction. The incessant emulation, the keen anxieties, the

worrying cares which beset modern commercial and professional life, are as things that have never been." Another important advantage lies in the pure atmosphere and the long hours of uninterrupted sunshine and air that may be obtained, particularly in the warm latitudes, where the passengers may almost live on the deck. Other advantages lie in the equability of the climate, which varies but little from day to day, with freedom from chill, the saline particles in the air, the abundance of ozone, and the high average range of the barometer at sea. Drawbacks are not wanting, and they consist principally in the monotony of life on shipboard, the paucity of amusement and distraction, and the occasional discomforts of severe weather. The longer the voyage, provided it fall short of producing intolerable *ennui*, the greater the gain to health. Hence a sailing-vessel may be preferable to a steamer. A sailing-vessel has the further advantage that its progress being less rapid, the changes of climate in north and south voyages are more gradual than on the steamer. Sea-voyages are recommended to those who are suffering from affections of the respiratory organs, and to those who are simply overworked and in need of rest and change. But "those far advanced in disease, from whatever cause, and those threatened with melancholia or other form of insanity, should avoid a long sea-journey."

Fauna of Deep-lake Bottoms.—Although vegetation appears to be absent, the fauna of the depths of the Swiss lakes, considering as at great depths all points over seventy-five or eighty feet below the surface, is rich and abundant. All the deep-water classes except echinoderms are more or less perfectly represented, and, while the number of species is not very great, the types are remarkably varied. The individuals composing this fauna are generally of smaller size than those of corresponding littoral species; they are more opaque than in the pelagic fauna, and are seldom colored, for they live in a darker medium than the sea; and they are poor swimmers, and have no organs of attachment. Some of these animals exhibit curious features of adaptation, among the most remarkable of which is the smallness or entire absence of the eyes in some species. But this defect is far from being uniform. Thus, while some animals may be found with good eyes at the depth of one thousand feet, others will be found totally blind at one hundred feet, where there is still some light. This curious fact is explained by Dr. Plessis by supposing that an emigration has been going on from an extremely remote period and is still continuing, from the littoral and pelagic regions to the deep zone. The species which have most recently performed this emigration have not yet lost their eyes, while the species that went down in earlier times have had them atrophied, and have transmitted the defect to their offspring, even in regions where there is still light. This view is confirmed by the fact that we can find in the same species individuals wholly blind, others with their eyes in the way of atrophy, and others with sound eyes, but small, according as they may have descended from stocks that have emigrated at different epochs. Another feature in which adaptation is shown is in the organs of respiration. There are larvæ of Diptera in the lake-bottoms having a tracheal system, like those of surface insects, opening without by stigmata; but instead of air these tracheæ are filled with water. The Lymnæ of the bottom exhibit the same peculiarity. Forel always found their pulmonary sac filled with water. But they resume their normal method of respiration with a surprising facility as soon as they are placed in contact with the air, and this without appearing to suffer in the least.

School-Life and Chorea.—Dr. Octavius Sturgis, of the Westminster Hospital, London, has called attention to certain events and circumstances of school-life which during the year have within his own experience given origin to St. Vitus's dance. A patient whom he has had under treatment, a girl eleven years old, had been observed, before her chorea began, to be "restless at night, crying out in her sleep, or sitting up and rambling about her lessons. She was always eager to be at her books, and would bring home school-work to be prepared overnight. Owing, however, to the pressure of domestic matters, the lessons were often left

undone, and as a consequence the girl was 'kept in' and otherwise punished. For some time the strange movements of the child had been noticed at home, but nothing was thought of them, and no change was made in the routine of her life. It was ascertained that there had been no intentional unkindness either at school or at home. The child was anxious to learn, but too little allowance was made for her scanty opportunities of mental culture, and she thus fell into undeserved disgrace." The malady is one which develops slowly, and is very rarely recognized at the beginning. "The rule is that for weeks or for months what is really disease is taken for carelessness or perversity, and a condition which needs for its cure the utmost tenderness and allowance is thus aggravated by repeated punishment."

NOTES.

THE fifth volume of the "History of California," in the series of Bancroft's Works, now just published, brings the record up to the discovery of gold in 1849. The publishers announce that they have been busily engaged in remanufacturing the stock that was consumed in the fire of April 30th, of which the edition of the present volume was a part, and that the delay and inconvenience caused by that disaster were only temporary.

THE editor of the Johns Hopkins "University Studies in Historical and Political Science" proposes a series of extra volumes to appear in a style uniform with the regular studies, but otherwise independent of them. The volumes will vary in size from 200 to 500 pages, with corresponding prices. The first volume will be published early in the season, as "The Republic of New Haven"; a History of Municipal Revolution. By Charles H. Levermore, Ph. D. It is a new study, from original records, of a most remarkable chapter of municipal development.

FROM a series of experiments which he has made upon the amount of water contained in highly lignified plants in various seasons and under varied conditions of growth, Professor D. P. Penhallow has drawn the conclusions that the hydration of woody plants is not constant for all seasons, and depends upon conditions of growth; that it reaches its maximum during the latter part of May or early June, and its minimum during January; that it is greatest in the sap-wood, and least in the heart-wood; and that the greatest hydration is directly correlated to the most active growth of the plant, while lignification and storage of starch and other products are correlated to diminishing hydration.

PROFESSOR W. MATTIEU WILLIAMS infers, from the examination of Count Rumford's "Essay on Gunpowder," that he produced solid carbonic acid in the course of his experiments on the explosive force of that composition. In an experiment with a confined cylinder, the count observed "an extremely white powder, resembling very light white ashes, but which almost instantaneously changed to the most perfect black color upon being exposed to the air." Professor Williams supposes that this white evanescent ash-like deposit was solid carbonic acid. The change to black mentioned by Rumford was caused by the instantaneous evaporation of the acid, causing to be revealed the ordinary black deposit of gunpowder beneath it. The pressure under which the experiment was conducted was 9,431 atmospheres, which is abundantly sufficient to effect the solidification of carbonic acid.

CONSIDERABLY more than four million persons had been, at the end of last year, insured against sickness under the German law of compulsory insurance. At the beginning of 1886 the compulsion to insure was extended to the whole administration of the post, railway, and telegraph, and to all trades connected with transportation; and a movement is on foot to extend the principle still further. The introduction of the system has not led to any diminution in the number of friendly societies or trades-unions, but many of them have had an enormous increase.

DR. W. J. GRAHAM, of Grafton, Dakota, has propounded a new theory of the origin of the alkali which is more or less abundant on the Western plains. He derives it from his observations, during several years' residence, of the soil, water, and atmosphere of the country. It is that the basis of the alkali is common salt, which is derived from a rock-salt formation underlying the region, by permeation to the surface, where it undergoes the chemical reactions which give it its apparent form and composition. Dr. Graham also believes that the alkali will afford a valuable and really inexhaustible fertilizing material.

PROFESSOR BROWN-SÉQUARD was, on the 21st of June, elected to the Section of Medicine and Surgery in the French Academy of Sciences, in place of M. Vulpian, who has been made perpetual secretary. Professor Brown-Séquard received thirty-six votes, to nineteen given for M. Germain Sée.

PROFESSOR L. WEBER relates, in a German periodical, that during a thunderstorm at Ribnitz, in Mecklenburg, the lower pane of a window on the first floor of a house was broken by lightning, and a jet of water was thrown upward through the hole to the ceiling, with such force that a part of the ceiling was broken down, and other damage was done. The hole in the window was like a bullet-hole, with radial cracks. Some cigars on a table, that was broken by the fall of the ceiling and the water, were carbonized. The origin of the jet of water, is not satisfactorily explained.

MR. THOMAS WARDLE, of Leek, England, has been to India and examined the cultivation of the silk-worm and the means still in use for reeling the silk there, with a view to suggesting means for improving them. Although the reputation of Indian silk has greatly declined during the last twenty-five years, he is satisfied that its fiber is quite equal to that of Italian silk, and that improvement in methods is all that is required. The Italian threads are, however, four times as long as those of the Indian cocoons. The profitableness of the silk-growing business is shown by the fact that the zemindars derive their very highest rents from lands devoted to it.

AN ancient—probably prehistoric—British vessel has been found at Brigg, in Lincolnshire, England, in the course of making an excavation of the ground for a new gas-holder. It is cut out of a solid piece of wood, and measures forty-eight feet in length, fifty-two inches in width, and thirty-three inches in depth. It is in a remarkably good state of preservation, because, probably, it was imbedded in a clayey soil which excluded the air. An ancient wooden causeway was discovered in the same neighborhood a few years ago. It was made of squared balks of timber fifteen feet long and ten inches square, which had been fastened to the earth by pegs driven through holes in the ends.

MRS. BRYANT has communicated to the Anthropological Society the result of some tests which she has made of the powers of perception, inference, and imagination, of a class of girls of about thirteen years of age, by asking them to describe some particular object from memory. The most noteworthy result was that due to a faculty which the author calls emotionalism. The emotional girls, who, in their descriptions, used such adjectives as "beautiful," "lovely," "sweet," etc., showed deficiency in more valuable traits of character; and it seemed that in those cases emotion superseded thought. Such tests as these might prove valuable in education and the choice of a profession, and, perhaps, in civil-service examinations.

MM. C. WEIGETT, O. Sacre, and L. Schwab, have investigated the effects on fisheries and fish-culture of sewage and industrial waste waters, and find them very damaging. Chloride of lime, 0·04 to 0·005 per cent chlorine, exerted an immediately deadly action upon tench, while trout and salmon perished in the presence of 0·0008 per cent of chlorine. One per cent of hydrochloric acid kills tench and trout. Iron and alum act as specific poisons upon fishes. Solution of caustic lime has an exceedingly violent effect upon them. Sodium sulphide, 0·1 per cent, was endured by tench for thirty minutes.

MR. JOHN URIE, of Glasgow, Scotland, has invented a new method of photographic silver-printing by machinery. A ribbon of paper is caused to travel by clock-work beneath a negative, which is let in to the top of a light, tight box. Above the negative is a powerful gas-burner, which is turned up and down automatically, as the paper pauses in its passage every few seconds. The strip of paper, which, at the end of a few minutes, bears perhaps twenty latent images of the negative, beneath which it has been traveling, is then developed by a suitable chemical agent to make those images visible.

M. PERROTIN has reported to the French Academy of Sciences concerning the observations he has been making upon the "canals" of Mars with the great equatorial which has just been mounted at the Nice Observatory. These are a feature of the planet which was first observed by M. Schiaparelli, and consist of grooves about twenty-five kilometres in width, having perfectly parallel borders, which are stretched across the Martian continents, between the seas. Nothing like them exists on the earth or the moon, or any other planet, so far as has been observed. Consequently, it is impossible to conceive any satisfactory explanation of their existence. M. Perrotin's observations have been verified by MM. Trépied and Thallon.

BESIDES the caves at Gomanton, in North Borneo, of which we lately gave an account in our Miscellany, the edible birds' nests are produced in caves in islands off the coast of the Malay Peninsula. The caves belong to the Siamese Government, and are farmed out to contractors. The harvest is during March and April. The nests are collected as soon as they are built, and before the swallows have begun to lay their eggs. The birds build second nests, and these are taken away; but the third nests are left. The caves are accessible only by means of rattan ladders, and the nests are collected from the rocks by means of rattan galleries and stagings. The Siam-

ese caves are wilder and more dangerous than those at Gomanton.

THE use of gas cooking-stoves is increasing in Great Britain. Many of the Scottish gas companies now let out the stoves at a cheap rate. Dr. Stevenson Macadam, speaking of gas-cooking in its sanitary aspects, says: "The wholesomeness of the meat cooked in the gas-stoves must be regarded as beyond doubt. Gas-cooked meat will be found to be more juicy and palatable, and yet free from those alkaloidal bodies produced during the confined cooking of meat, which are more or less hurtful, and even poisonous." A joint cooked in a gas-oven weighs heavier than the same joint cooked in a coal-oven, because the juices are more perfectly preserved in it.

PROFESSOR W. MATTIEU WILLIAMS calls attention, in "Science Gossip," to the danger of the extermination of the sole—one of the best of food-fishes—by trawling. The vessels, which are numbered by the thousand, sweeping the sea-bottom with a track as broad as their own length, scour each an acre an hour. If they are steamers, the effect is vastly magnified. Forty years ago, when the "Silver Bank" was a fresh fishing-ground, soles were retailed in London at twopence a pound, and enormous specimens were abundant. Gradually the size diminished and the quantity declined till the harvest consisted chiefly of "slips." Now the Silver Bank is practically ruined, and the price of soles has risen about one thousand per cent.

M. BRÉAL, a French writer on educational subjects, remarks, in his essay on the method of acquiring foreign languages, that when a person goes to a foreign country to learn the language he rarely succeeds; but, if he goes to pursue some particular profession or business, he learns the language rapidly and thoroughly—first the language of that business, then the language of ordinary intercourse, and so on step by step, in the order of nature. Thus it is the natural method that prevails.

THE "Lancet" makes a distinction between what it calls the use and the abuse of tobacco. The man who can say, "I always know when I have smoked enough—if I go beyond the just limit I lose my power of prompt decision," is one, it suggests, who had better not smoke at all; but "a moderate use of tobacco soothes the senses, and leaves the mental faculties free from irritation, and ready for calmly clear intellectual processes. When this is not the effect produced by smoking, the "weed" had better be eschewed.

MR. GEORGE J. ROMANES, having observed a rat, under circumstances in which it should have been badly frightened, manifest great savagery and voraciously devour its companion, persisting in biting it till the last moment of consciousness, has been led to inquire whether the case is one of peculiar ferocity, or of emotional insanity produced by extreme terror. He wishes to know how wild rats ordinarily behave when shut up in a cage together.

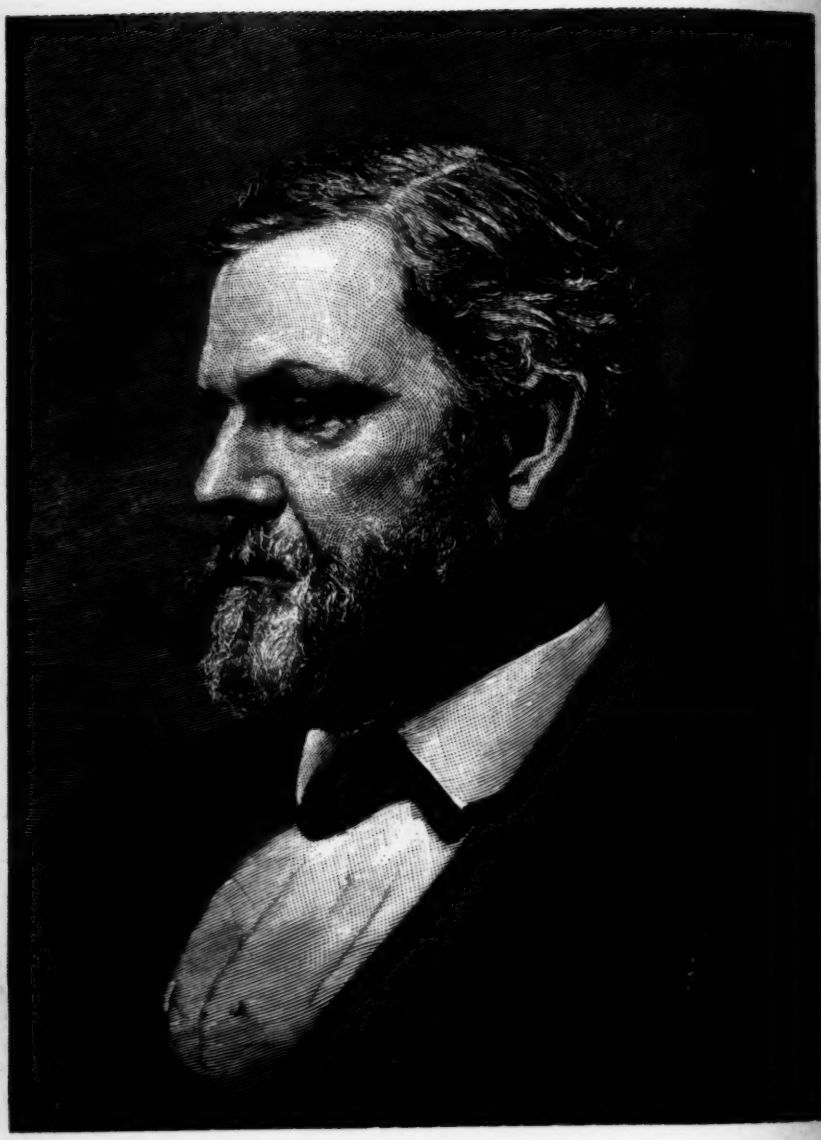
IT is definitely asserted by the engineer of the Suez Canal that the annual mean level of the Mediterranean at Port Said is the same as the annual mean level of the Red Sea at Suez; and that, according to the observations of the Panama Canal Company, there is no difference of moment between the levels of the Atlantic at Colon and of the Pacific at Panama.

OBITUARY NOTES.

PROFESSOR WILLIAM RIPLEY NICHOLS, of the Massachusetts Institute of Technology, died in Hamburg, Germany, July 14th, in the fortieth year of his age. His death was caused by a disease of the lungs, from which he had been suffering more or less for four or five years. He was graduated from the Institute in 1869, in its second class, and was shortly afterward appointed Professor of General Chemistry in it. He was the author and compiler of several text-books on general and inorganic chemistry. He made a specialty of water analysis, in which he acquired a high reputation for accuracy and probity; he studied the ventilation of railroad-cars and the effect of the atmosphere of smoking-cars, and did much work for the Massachusetts State Board of Health.

PROFESSOR SHELDON AMOS died at Ramleh, near Alexandria, Egypt, January 3d, at the age of fifty years. He was the youngest son of the late Andrew Amos, Professor of Law at Cambridge, and was called to the bar in 1862. He was for several years Professor of Jurisprudence at University College, London, but spent many of the later years of his life abroad, in Australia and Egypt. He was for several years, and till his death, English Judge of the new Egyptian Court of Appeals. He was the author of several legal treatises.

DR. WILLIAM KING, Emeritus Professor of Geology, Mineralogy, and Natural History in Queen's College, Galway, Ireland, died June 23d, in his seventy-ninth year. He was elected to his professorship on the foundation of the Queen's Colleges in Ireland, in 1849, and filled it actively till 1883.



JOHN NEWTON.